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Mechanical Die-Sinking

by
Edward K Hammond[1]

THERE are many lines of manufacture in which the drop-hammer or power press is used to produce a series of parts of the same design but of a variety of sizes. Instances of this kind are found in the cutlery, hardware and other trades; and the manufacture of such series of products naturally calls for the making of dies for each individual part. Formerly, it was necessary for all these dies to be made by hand, and the expense involved was an important item in the cost of production.

For many years the reducing type of die-sinking machine built by the Keller Mechanical Engraving Co., 70 Washington St., Brooklyn, N. Y., was used exclusively for more or less ornamental work—in making embossing dies for silverware, dies used in the manufacture of builders' hardware, and similar products. Recently it has been found that the same principle of die cutting can be used to advantage in making series of dies for the manufacture of these complete lines of work of the same design but of different sizes.

This machine works from a model of larger size than that of the die to be produced, and any desired ratio may be obtained between the size of the model and the work. When this die-sinking machine is employed, it is merely necessary to make a single large model, which may be used for producing a series of different sizes of dies; after the model has been completed, the personal equation is eliminated, the work being reduced to a simple manufacturing process without any of the technical details of die-sinking, such as laying out the work, constant measuring, etc. The machines work more rapidly than the most skillful die-sinker, and a high degree of accuracy may be obtained. All manufacturers who require considerable numbers of dies experience difficulty in securing the necessary number of die-sinkers to handle their work. It takes a mechanic of the highest order to make a really good die-sinker, and men possessing the required ability are more than likely to find an opportunity for better paid employment in other fields of activity; hence, the demand for die-sinkers is normally in excess of the supply.

[1] Associate Editor of MACHINERY.

An article in the September, 1915, number described the uses of the duplicating type of die-sinking machine in the production of drop-forging dies. This is the type of die-sinking machine generally employed for making dies used for mechanical products. The reducing type of die-sinking machine has been identified largely with the production of dies used in the manufacture of artistic and ornamental work, such as silverware, coins, medals, etc. The duplicating machine has many important uses in making silverware dies in addition to the purposes for which it was originally designed, and in the same way it has been found that the reducing machine may be used for making dies employed in the manufacture of other products than those with fine ornamental details in their design. Typical examples are found in the manufacture of cutlery, builders' hardware and die-pressed products.

Making Patterns for Drop-forging Dies and Other Plain Dies

The first step in producing dies for use in the manufacture of a given product is to make a model which can be used on the die-sinking machine for making the various dies that are required. Figs. 2 and 3 show examples of work for which it is necessary to make a series of dies of the same design but of different sizes in order to provide for the manufacture of a complete line of work, and these illustrations show very clearly the requirements which must be met in making models. In the case of the work shown in Fig. 2, the preliminary model would be made of wood, from each half of which a plaster cast would be made; and a metal cast made from this mold would be used as a model on the machine. The object of making the intermediate plaster cast is to bring the metal model made from this mold back into the same condition as the wooden model, *i. e.*, in relief or intaglio, as the case may be. In certain cases, however, the model can be made directly from metal. This is work which can be handled by any pattern-maker. In the case of door plates, as shown in Fig. 3, similar methods are employed; but for work of similar character, it is often advantageous to make the model from sheet metal laminations. These are cut out so that the profile of each piece follows the outline of the work at that level, and when the different laminations are assembled, they form a model which can be used on the machine without the necessity of making a casting. After the model has been completed, the personal equation is practically eliminated from the process of die-sinking, as the use of the machine reduces it to a simple manufacturing operation.

Cutting Lettering and Numbering Punches

An important application of this method of die cutting is in the making of steel lettering and numbering punches. For this

work the model is customarily arranged as shown in Fig. 4, *i. e.*, it consists of the letters of the alphabet or figures arranged in a circle; and the steel blanks for the punches are also carried in a fixture designed to hold them in a circle so that the complete set may be cut at once. A finished set of punches of this kind is also shown in Fig. 4. In this work the possibility of making punches of various sizes from the same model is of particular importance because a whole series of sizes of punches can be made from one model, thus effecting a considerable saving in the cost of production. Models for work of this kind may be made in various ways, but one of the simplest methods is to secure a set of printer's type faces of the desired style and group these in a circle as shown in Fig. 9, so that the required plaster and bronze casts may be made from them.

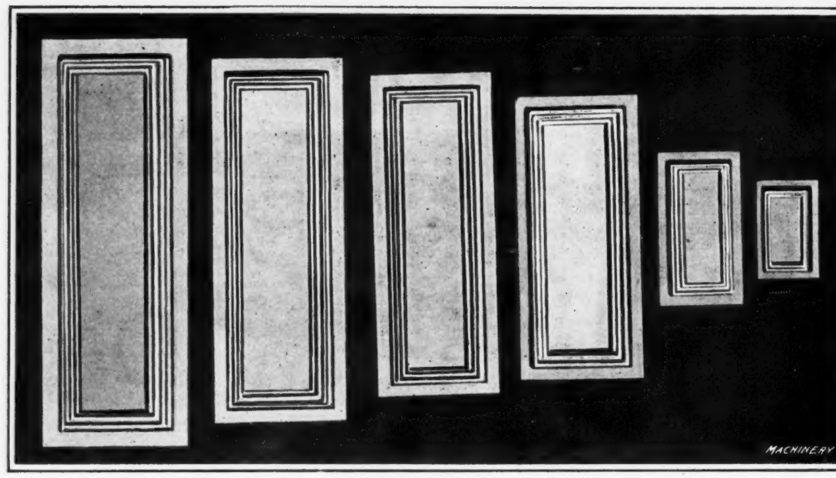

Fig. 3. Series of Door Plates made in Dies cut on Reducing Machine by the Use of a Single Model

In addition to making lettering and numbering punches, the reducing machine may also be used to advantage in making dies required for the production of a great variety of name and number plates used on machinery and for many other purposes. An example of this kind is shown in the illustration Fig. 9.

Making Punches and Dies for Sheet Metal Products

At the left in Fig. 6 is shown a highly decorated part which is stamped with machine cut dies instead of being engraved by hand, which was the original method of procedure. The design is embossed from a sheet metal blank, and attention is called to the fact that both the male and female dies are cut on the machine from models produced from a single wax model. The possibility of making both halves of a die in this way is of particular importance in making dies for many classes of sheet metal work, as it does away with the necessity of raising a force from the die.

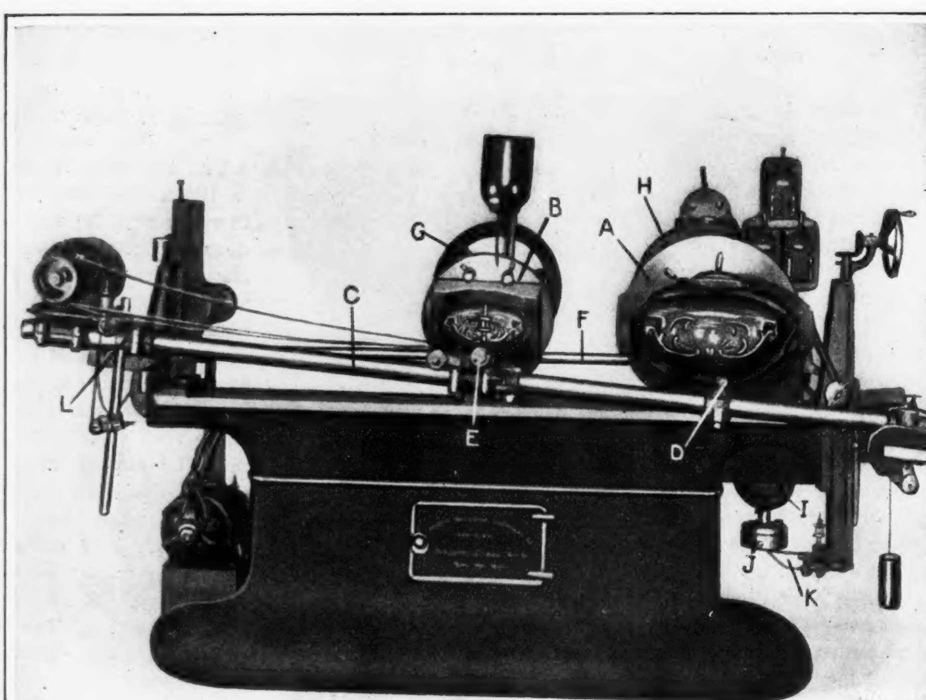

Fig. 1. Keller Reducing Type of Die-sinking Machine

Advantages of Having Model Larger Than Work

In all classes of die cutting done on the reducing machine several advantages are secured through having the model of larger size than the die which it is required to cut. Important among these is the fact that extreme accuracy is easily obtained, because any discrepancy in the model is minimized in making the reduction; also in making a model of relatively large size, it is often possible to work to better advantage than in producing a model of the same size as the work. This applies to both plain mechanical work and ornamental work.

The tracer point is made larger than the cutting tool in the same proportion that the model is larger than the work, and in cases where the pattern is extremely deep or narrow the tracer runs over a large model more easily than it would if the model were made the same size as the work. A case in point is seen in the model that was used in making dies employed in the manufacture of horseshoe calks, a plaster cast of such a die being shown at the right in Fig. 6. It will be evident from the illustration that this die is of considerable depth as compared with the distance across the opening, and it will also be noticed that the sides of the die are relatively steep. By having the model several times larger than the work and using a rotating tracer point and a five-degree cutting tool, very satisfactory results were obtained.

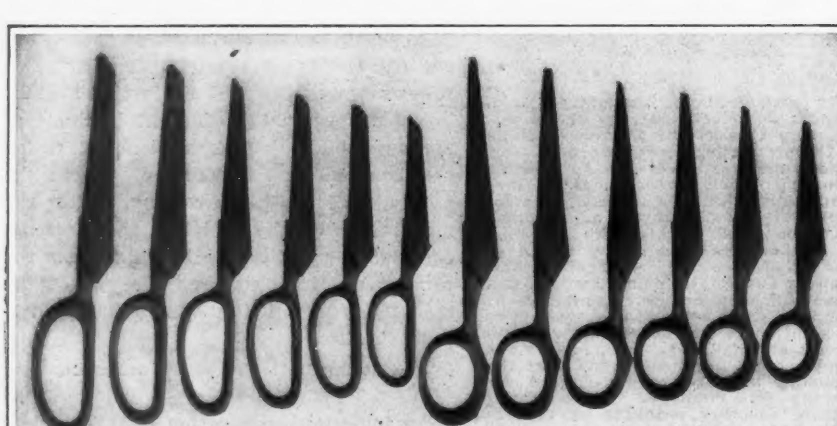

Fig. 2. Scissor Forgings made in Dies cut on Reducing Machine from Two Models

Keller Reducing Machine

A front view of the reducing machine is shown in Fig. 1, and by referring to this illustration in connection with the following description, the operation of the machine will be readily understood. Two revolving

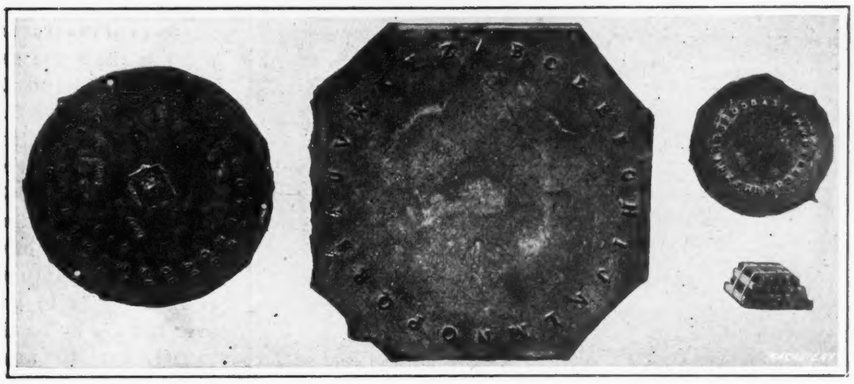

Fig. 4. Models used in making Lettering Punches and a Finished Set of Punches

faceplates A and B are provided on the machine, and the enlarged model is secured to faceplate A while the block in which the die is to be cut is carried by faceplate B. Bar C carries a tracer point at D, which moves over the face of the model, and a rotary cutting tool at E, which cuts the die. This bar C is carried by a double-pivoted support at its left-hand end, which allows the bar to swing in and out as the tracer point moves over the contour of the revolving model, and also permits the bar to swing in a vertical plane as the tracer point and tool are fed down from the center of the model toward the periphery. It will, of course, be evident that the cutting tool moves in or out from the work as the tracer point passes over low or high spots on the model, and that this action, in conjunction with the rotation of the work and feeding of the tool from the center to the periphery, results in the reproduction of the model in the die-block. To make the in and out movement of bar C, caused by the contact between the tracer point and work, as easy as possible, the right-hand end of bar C is supported by a roller. The relative size of the work and the model is determined by the ratio of the distances of the cutting tool and the tracer point from the pivot about which the bar C swings. Faceplate A occupies a fixed position in relation to bar C, while faceplate B may be adjusted to provide for obtaining the required size for the work. At the back of the machine there is a scale divided into 1000 spaces, and the center about which faceplate A rotates is located at a distance of 1000 units of length from the pivotal support of bar C. Then by setting faceplate B at the required distance from the pivotal support, the work may be produced in a given proportion to the size of the model. By reversing the positions of the work and model, *i. e.*, placing the model on faceplate B and the work on faceplate A, an enlargement can be made instead of a reduction. This practice is sometimes followed when it is desired to make model enlargements in plaster or wax.

Fig. 5. Model-making Department of Keller Mechanical Engraving Co.

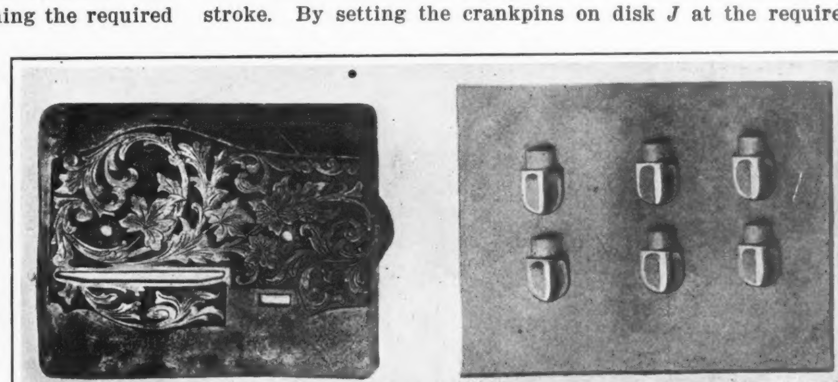

Fig. 6. Sheet Metal Product where Male and Female Die were made from Same Wax Model; and Work where Depth of Die made Enlargement of Model an Advantage

Operation of Die-sinking Machine

In order to present a comprehensive description of the way in which the machine operates, it will first be necessary to enter into a somewhat more detailed description of its mechanical features than that previously given. It will be seen that two motors are employed. The motor which drives the rotary cutting tool (and rotates the tracer point in cases where the use of a rotating tracer point is required to run over a model where there are abrupt changes in contour) is mounted on a bracket clamped to the end of bar C. This mounting of the motor is necessary in order that swinging of the bar may not result in variations of the belt tension, which would seriously impair the free movement of the bar C and the driving efficiency of the belt. The second motor is mounted at the left-hand end of the machine, and is used to drive the faceplates A and B, and to actuate the feed mechanism which moves the tracer point and cutting tool from the center out toward the periphery of the pattern and work, respectively. The two faceplates are driven by worms on the horizontal shaft F, which mesh with the worm-wheels shown at G and H.

To provide for feeding the tool out from the center to the periphery of the work, horizontal shaft F transmits power to a vertical shaft which runs down through the gear-case I. This case contains an arrangement of back-gears which may be engaged for slow feed motions, or the drive may be carried direct for operating on work where a fast feed can be employed. Below the gear-case, there is a disk J which carries two adjustable crankpins to which the links K are connected. The crankpins may be adjusted on disk J with relation to the center of rotation so that any desired throw is obtained. Links K make connection with a vertical feed-screw which lowers the bracket that supports the right-hand end of bar C. Links K have an oscillatory motion, so that on the forward stroke one of the links rotates the screw, while the other link rotates the screw during the return stroke. By setting the crankpins on disk J at the required

distance from the center, a suitable rate of feed may be obtained for the work being handled.

In cases where the design to be cut is round or square, it is feasible to have the tracer point follow a continuous spiral in passing over the work. In other cases the work may be of oblong or irregular outline, so that the tool would only be cutting during part of each revolution, and to have the faceplate revolve continuously on such work would result in the loss of much time. To avoid this, stops are provided at the back of faceplate *B*, which trip a switch governing the reversing motor at the left-hand end of the machine, which drives the faceplates and feed mechanism. This causes the direction of rotation to reverse after the tracer point has passed over the model, so that it immediately starts back in the opposite direction, with the result that there is no loss of time. The tracer point and tool are fed out from the center of the model and work at a uniform rate, but it will be evident that the cutting speed would increase considerably as the tool moved out from the center toward the periphery of the work if the speed of rotation were maintained uniform. To prevent this, a variable-speed mechanism is provided which automatically reduces the speed as the cutter moves out from the center, so that a uniform cutting speed is maintained.

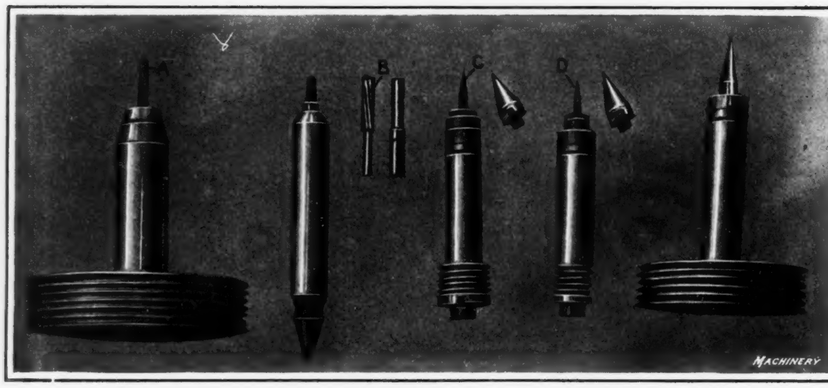

Fig. 7. Roughing, Intermediate and Finishing Cutters and Tracer Points

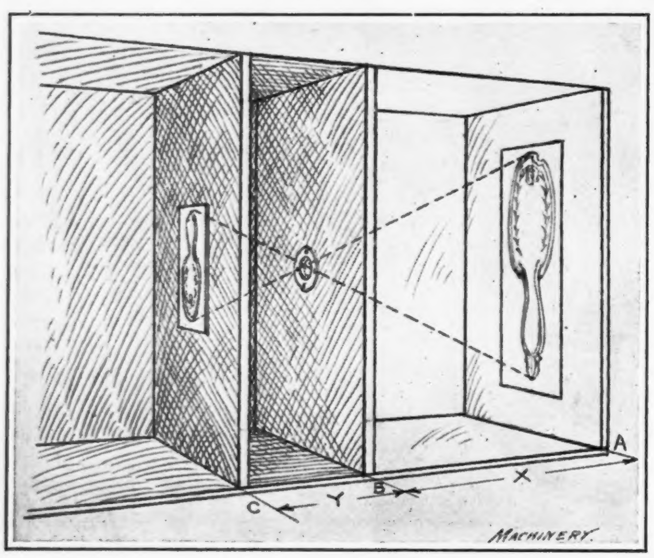

Fig. 8. Camera-obscura used in reducing Drawings to Required Size

Cutting Tools and Tracer Points

When the model and die-block have been set up on the machine, and the position of faceplate *B* has been adjusted to produce work of the required size, the machine is ready for operation. It is usually necessary to take roughing, intermediate and finishing cuts in order to complete the work. The roughing out or "hogging" cut is generally taken with an ordinary end-mill, while the intermediate and finishing cuts are taken by special cutters, examples of which are shown in Fig. 7. In each case the form of the tracer point is the same as that of the tool used in connection with it, but it varies in size in the same proportion as the model and the work. After the finishing cut has been taken, all that is required is to go over the die by hand to clean up any rough spots and remove all tool marks. The dies produced are extremely accurate, and not only avoid loss of time due to the failure of drop-forgings to fit in fixtures used for subsequent operations, but also reduce machining time by cutting down the amount of metal to be removed to a minimum.

Repairing Worn Dies and Replacing Broken Ones

In addition to the advantages secured through using machine made dies, to which reference has already been made, mechanical die-sinking is the means of enabling dies to be repaired very rapidly. In case a die has become too deep, it is set up on the machine and a cut is taken over the top face to remove an amount of metal slightly in excess of the error in depth of the die. Then a finishing cut is taken, using the regular model to guide the cutting tool. Dies made of good steel can be annealed and refinished in this way two or three times.

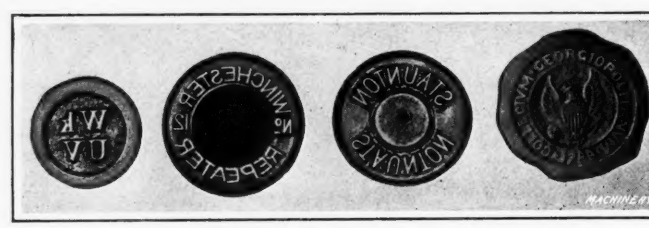

Fig. 9. Examples of Lettering done in Dies made on Machine

Mechanical Production of Dies

In making embossing dies used in the manufacture of silverware and other products where there is a great deal of fine decorative work in the design, it would be impracticable in many cases to make a model of the same size as the work. For dies of this kind, the reducing machine is extremely useful, because the model can be made large enough to enable all details of the design to be of sufficient size so that they can be accurately produced; and then this model can be used, with a proper setting of the machine, to enable the desired degree of reduction to be obtained. The machine is very accurate, and if a powerful magnifying glass is used to look at small work of intricate design, which has been produced from a large model, it will be found that each detail shows up with almost absolute precision. It was for handling work of this nature that the reducing machine was originally developed, and its application in making dies for use in the manufacture of silverware, etc., is well known in that trade. But there are many readers of MACHINERY who have never had an opportunity of visiting plants engaged in such lines of manufacture, and they will doubtless be interested in the following description of the way embossing dies are produced.

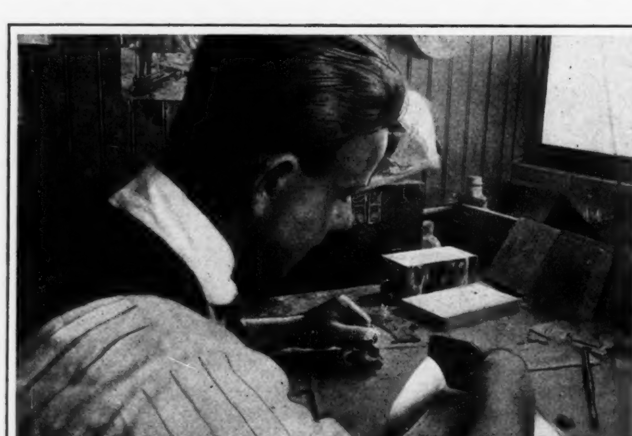

Fig. 10. Use of Templet and Sweeping Gage for forming Edge of Model

Making the Drawing for the Model from which Dies are Produced

In making a model for an embossing die which is to be produced on the Keller reducing machine, it will be obvious that the first step is to make a drawing. Where there is any appreciable amount of intricate detail on the work, it is advantageous to make this drawing of considerable size, and, in fact, this is desirable in most cases. After the preliminary drawing has been completed, it will be required to make a drawing of the actual size of the model, and for doing this part of the work an ingenious application of the camera-obscura principle has been made in the Keller factory. This arrangement is shown diagrammatically in Fig. 8. Its essential features consist of a model board A upon which the original drawing is tacked up; a fixed screen B in which a lens is mounted; and a ground-glass screen C upon which the image of the drawing is projected. The entire outfit is housed in a room with light-proof walls, and the walls of the room at the front of screen B are painted white, this part of the room being illuminated by a flaming-arc light. Behind screen B, the walls of the room are painted dead black to cut off reflected light as far as possible. Ground-glass screen C is mounted on a truck on which the operator sits, and the position of this truck in relation to screen B may be adjusted by turning a handwheel. Model board A is also mounted on wheels, and the distance X from this board to screen B can also be adjusted by means of a cord which runs over a set of pulleys and extends back within reach of the operator.

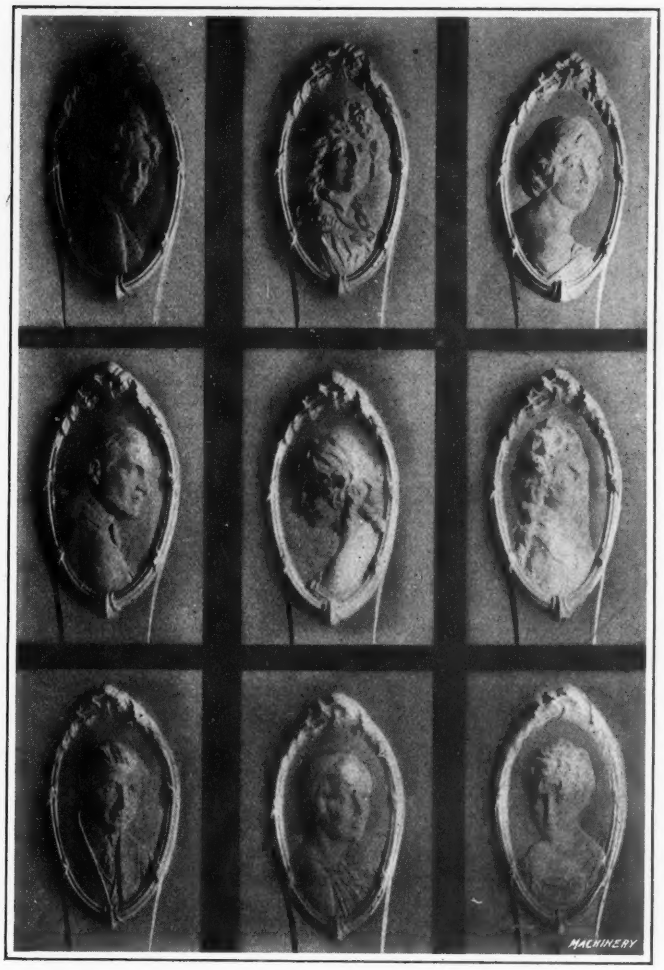

Fig. 11. Impressions from Spoon-handle Dies used in making Souvenir Spoons for Distribution in Moving Picture Theaters

In order to get any definite relation between the size of the original drawing and the size of the image which is projected on the ground-glass screen C, it is merely necessary to adjust distances X and Y so that the ratio of X to Y is equal to the ratio between the size of the drawing and the required size of the image. For instance, suppose it is desired to obtain an image 6 inches high from a drawing which is 24 inches high. The setting will be in the following proportion:

$$\frac{X}{Y} = \frac{24}{6} = \frac{4}{1}$$

Hence model board A will be located at a distance of 4 feet from screen B, and ground-glass screen C will be at a distance of 1 foot from screen B. As a matter of fact, this calculation is not made, because the operator adjusts the model board A and screen C until the desired size of image is obtained, which he determines with a ruler. To make the working drawing, it is then only necessary to secure a sheet of tracing paper in place on the ground-glass screen C and make a tracing of the required size, which is used in laying out the model.

The Keller Mechanical Engraving Co. does an extensive business in making various types of dies, and the arrangement for making the drawings described in the preceding paragraph is ideal for any shop which has a large amount of work to do. Such an outfit occupies considerable space, however, and is naturally somewhat costly to make. As a result, many shops will find it more desirable to use some simple method of reducing the scale of drawings, which will give perfectly satisfactory results, although more time may be required for doing the work. The familiar pantograph device used in drafting-rooms will be found to be satisfactory.

Making the Preliminary Wax Model

After the working drawing has been finished, the next step in the production of the model consists of reproducing the design in wax. The method of procedure will necessarily be governed by the character of the work, but numerous labor-saving devices and short-cuts have been developed to reduce the amount of time required to a minimum. For instance, it sometimes happens that models are to be made for a series of dies, all of which are of the same outline; and it may also happen that the edges of all of these models are to be of a given form. A rapid method of handling such work is to make a sheet-metal templet of the shape of the base of the model and a "sweeping gage" for forming the edge, which is moved around the base of the templet as shown in Fig. 10. The wax, from which the preliminary model is made, is placed upon the templet and worked up into approximately the desired shape, after which the sweeping gage is run around the periphery of the templet, cutting away enough of the wax to bring the edge of the model to the required form.

Fig. 12. Finishing Dies by Hand to remove Tool Marks

After this has been done, the modeler can proceed to work from his drawing to finish the model. For the benefit of those who are not familiar with the work of modeling, it may be said that the work is done by hand with a

variety of small spatulas and engraving tools; it consists essentially of hand-carving, and very exact results may be obtained. For instance, the Keller factory has recently been working on a set of dies to be used in making souvenir spoons to be distributed among the patrons of moving picture theaters. These spoons have the likenesses of different "movie" actors engraved on their handles, impressions of these dies being shown in Fig. 11. Photographs of the actors were sent to the factory and the modelers worked direct from these photographs, producing models which were, in every sense, as true to life as the photographs. It will be obvious that the wax model is too soft for use on the machine, and in order to make a model which will stand up under actual working conditions, a plaster-of-paris cast is produced from the wax model; this plaster cast is then used to make a bronze cast, which is the model that is actually used on the reducing machine. In casting the bronze model, great care must be taken to avoid all defects which are likely to appear in castings; but where the necessary precautions are observed, the bronze cast is ready for use on the machine without requiring any appreciable amount of mechanical or hand treatment.

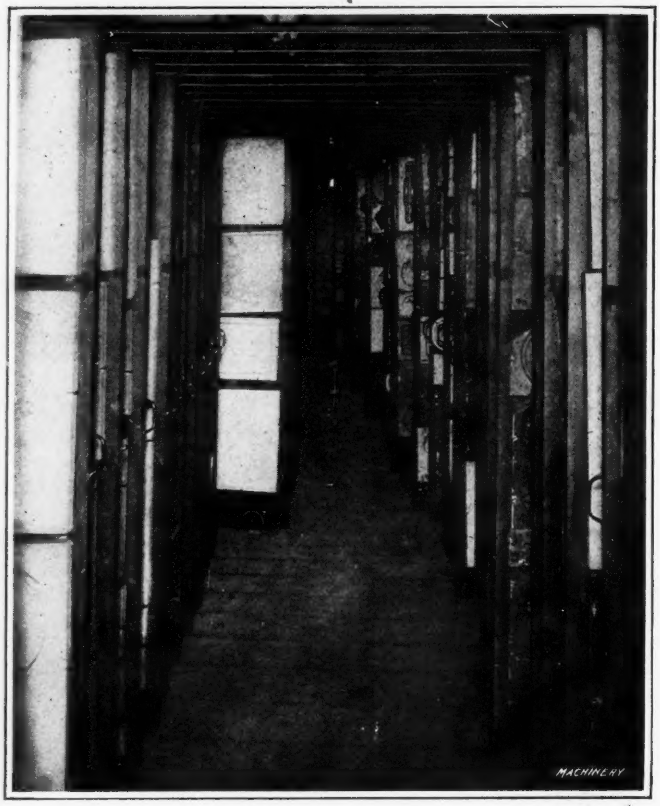

Fig. 13. Store-room equipped with Vertical Racks on which are stored Plaster Casts from All Dies made in Shop

The description of the method of making models would be incomplete without referring to the way in which models of the same design but of different proportions are made up from the same wax model. This is frequently done in the case of symmetrical designs and saves the expense of making a new model in wax. For the purpose of discussion, suppose that it is required to make a part similar to any of the symmetrical designs shown in Fig. 3, but that a different ratio of width to length is required. The size of the model is immaterial, as the required reduction can be obtained by making the proper setting of the machine, but the proportions must be correct. In such cases, the expedient has been adopted of cutting the plaster cast through the center and removing the necessary amount of material so that the required ratio between the width and length is obtained. The halves of the plaster cast are then stuck together again and this cast is used in making a bronze model for use on the machine. While this seems like a makeshift method, it gives very satisfactory results and saves all the labor incident to the production of a new wax model.

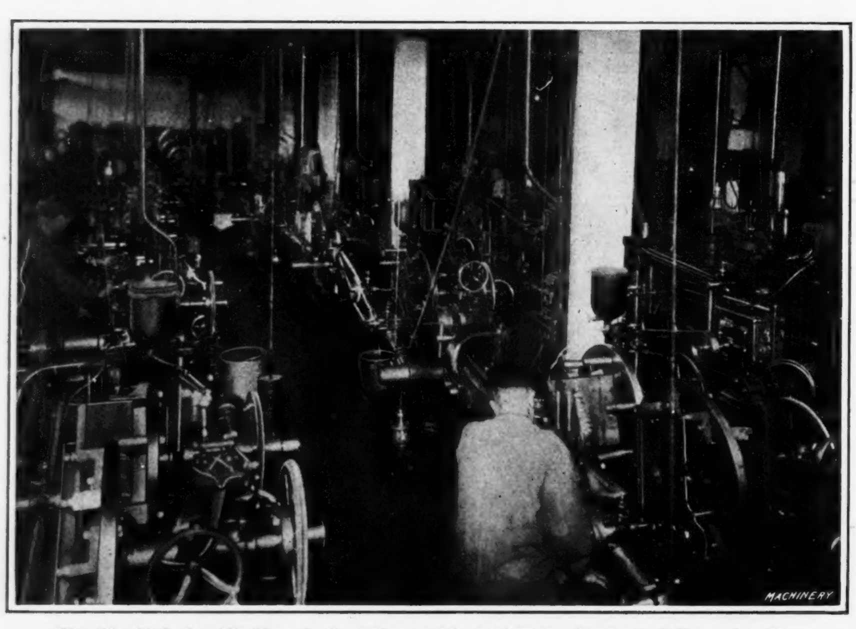

Fig. 14. Reducing Machines in Operation at Plant of Keller Mechanical Engraving Co.

In making dies for decorative work, a certain amount of latitude is allowed in setting the machine to obtain the desired effect. For instance, in making a set of embossing dies, it may appear that too much relief is being obtained to give the desired appearance to the work. In such a case, adjusting the longitudinal position of faceplate *B*, Fig. 1, on the machine bed would result in changing the relief, but this would also make a corresponding change in all other dimensions of the work, which would be out of the question. To overcome this difficulty, an adjustment has been provided which permits of changing the position of the center of oscillation about which bar *C* swings in a horizontal plane without moving the center of vertical oscillation. This enables a greater or lesser amount of relief to be obtained on the work without making it necessary to change the other dimensions.

Conclusion

In MACHINERY for September, 1915, an article entitled "Mechanical Production of Drop-forging Dies" explained the use of the Keller automatic profiling machine used for this purpose. Readers of this article will recall that the machine referred to is used for producing work from a model of the same size as the work. The advantages of the reducing machine in making a series of different sizes of dies from a single model and in handling work where there is a great deal of fine detail in the design have been explained in the present article; but there are relatively few classes of work handled on the automatic profiling machine which cannot be done with almost the same facility on the reducing machine. For this reason, manufacturers who desire to use their machines for a variety of work, but who do not have enough work to keep one or more machines of each type busy, will find that the reducing machine is best suited to their requirements.

* * *

EXPLOSIONS

An explosion is almost certain to be very serious. Like nearly every accident, explosions are the result of not thinking or knowing what will happen. Here are some things that cause explosions in shop work: (1) Pouring hot metal on a wet spot. When hot metal strikes any liquid a violent explosion takes place. (2) Sparks flying from a welding machine into a small can of gasoline. Always keep gasoline well away from sparks or fire of any kind. (3) Turning gas on in a furnace too long before lighting. Be absolutely sure you know how to light a furnace before attempting to do so.

MAKING A SANITARY TRAP

BY ERNEST A. WALTERS[1]

The making of a sanitary trap tube is one of the many difficult operations encountered in tube working, and must therefore be developed with care, judgment and patience until the proper tools have been found for making a particular piece of work. Referring to Fig. 1, *B*, *C* and *D* show the sequence of operations on the tube *A*, which is made from 16 gage seamless brass tubing. The first work on the piece is cutting it to length in an ordinary tube cutter and then bending in two separate operations, after which the piece is finished by putting it through an opening-up die and driving balls made from high-speed steel through the tube with a hardened tool steel plunger. The first five balls used to open the tube at the radius which has collapsed during the previous bending operation vary from ½ to 1⅛ inch in diameter.

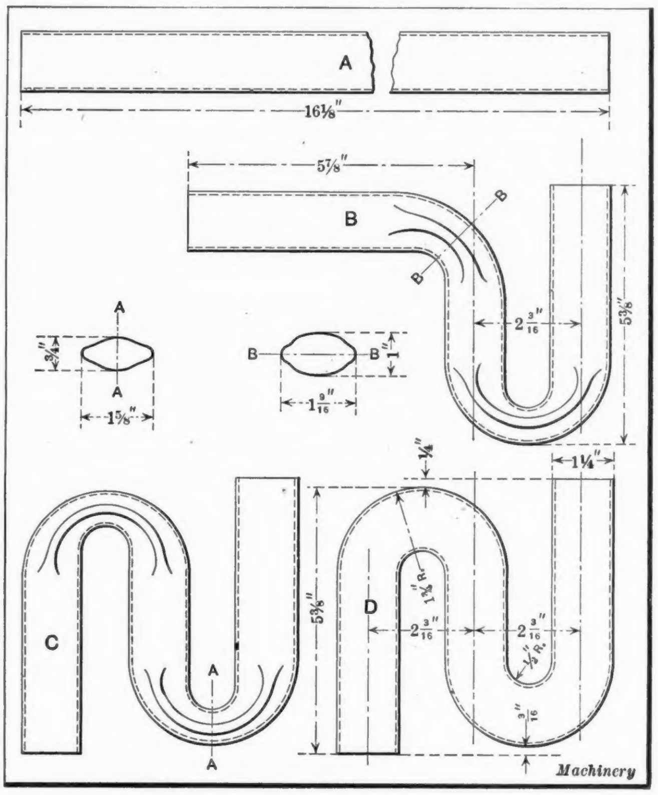

Fig. 1. Various Steps in bending Pipe for Sanitary Trap

First Bending Operation

Fig. 2 shows the bending die used in the first operation, which is that of bending the tube to the form shown at *B* in Fig. 1. *A* is the punch shoe and *B* the die shoe, both of which are made of cast iron. Proper alignment is insured by the guide pins *C* piloted in the guide pin bushings *D*. The punch *E* is dovetailed in the shoe *A* and is held in place by fillister-head screws *F*. The die *G* is made in sections, seated in the shoe *B*, and secured by the screws *H* and pins *I*. The pressure pad *J* receives the proper tension from the springs *K* on the rods *L*, which is transferred to the plate *M* that moves up and down on the guide pins *N* and supports the pressure pad. Care must be exercised to put the proper tension on the pad *J* in order to prevent the tube from collapsing at the bending point. The hole *O* is for fastening the punch shank in the press ram. The tube is shown in place at *X* ready for the bending operation.

Second Bending Operation

Fig. 3 shows the method of bending the tubing for the second operation in which it is shaped to the form shown at *C* in Fig. 1. The punch shoe *A* is made of cast steel and the die shoe *B* of cast iron. The die and punch are aligned by guide pins *C* in bushings *D*. Punch *E* is made from hardened tool steel and is secured by the screws *F*. The bending die is made in sections of hardened tool steel which are held in position by screws *G* and pins *H*. Pressure pad *I* is supported by pins *J* which rest on the plate *K* and are given proper tension by the rubber buffer *L* held in place by the bolt *M* and adjusted by the nut *Q*. *P* shows the tube in place, ready for the bending operation.

[1] Address: 219 W. Buena Vista, Highland Park, Mich.

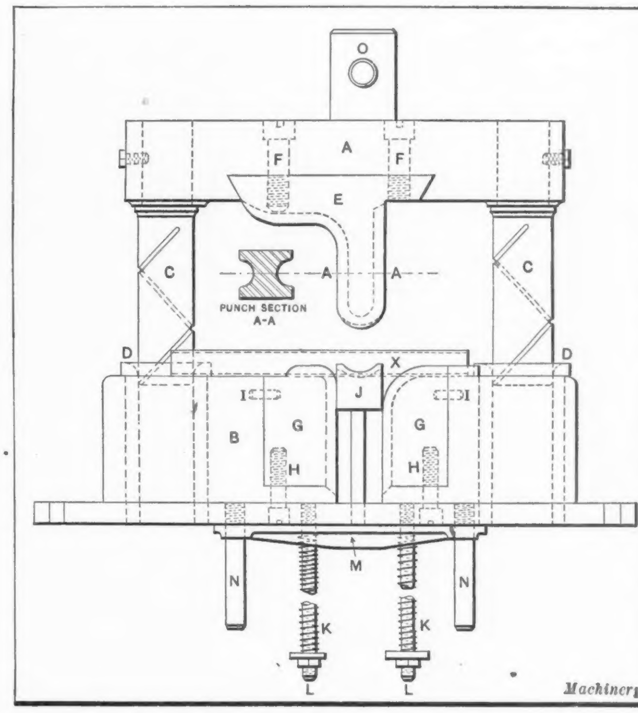

Fig. 2. First Bending Punch and Die

Third Bending and Opening Operation

The third operation on the piece is shown in Fig. 4, in which the tube is formed as shown at *D* in Fig. 1. In this case *A* is the tool steel hardened punch, and *B* the cast-iron die shoe. The die *X* is made from tool steel and hardened. The die sections are opened and closed by means of the cam lever *C*, assisted by the spring *D* in the die and the pin *F*. The chute *E* carries the discharged balls *G* into a separator placed at the end of the tube so that they automatically arrange themselves in position for the operator to handle when opening the next piece. The upper view shows the tube in position with the balls *G* being driven through the first radius by the ram operating the plunger *A*.

It is obvious that the tube *D* in Fig. 1 must be opened grad-

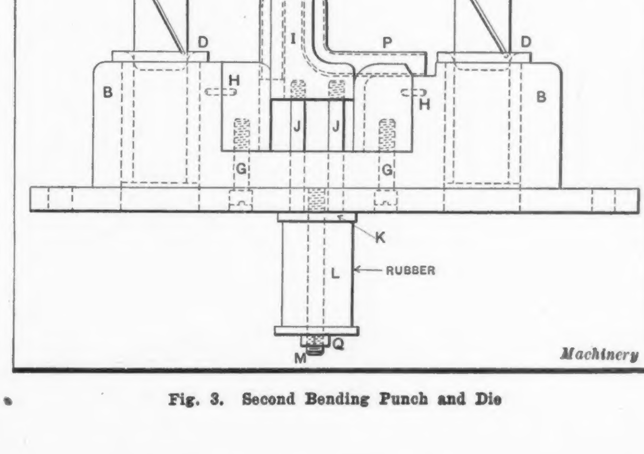

Fig. 3. Second Bending Punch and Die

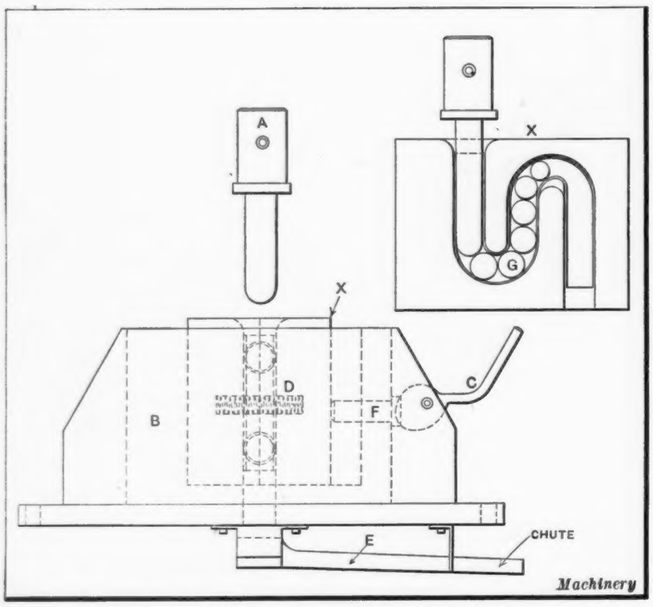

Fig. 4. Method of opening up Pipe after bending

ually, and therefore the balls used in this operation are made in step sizes. Before forcing the balls through the tube, the tube is dipped in a solution of water, oil and soap, thoroughly mixed, after which it is placed in the die as shown in Fig. 4. This die is closed by means of the cam lever *C*, and the first five balls, arranged in the order shown, are quickly dropped into the tube, the plunger forcing them into the position shown in the upper view. It will be seen that the punch advances the balls past the first radius in the tube, so that it gradually commences to open; as the plunger is withdrawn on the return stroke of the ram, five more balls 1/32 inch smaller than the inside of the tube are deposited in the tube, and the punch descends, driving the first five balls through the second radius, which is thus gradually opened. This process is repeated with four more balls 1/32 inch smaller than the tube, which drive the large sized balls completely through the tube and bring it up to size. The completed tube can then be removed and another inserted in its place.

* * *

CASTING BRASS AROUND STEEL TUBING

To cast a perfect brass casting around a piece of steel tubing without injury to the tubing and in a manner which insures a tight connection between the two is the unusual operation described in the following. This casting, an enlarged view of which is shown in Fig. 2, is a control lever fitting on the handle-bar of a motorcycle. After being machined as shown, it forms a foundation on which to attach the several control levers of the motorcycle. The cast-iron mold shown in Fig. 1 is made in two parts, one of which is stationary, and the other movable to permit of the removal of the casting when cooled. The movable half of the mold is operated by a long hand-lever which, in turn, is attached to other levers forming a toggle link action. Some ingenuity was used in making the mold. Originally a model of the casting was made of plaster and attached to a piece of tubing. Around the model was cast the mold in cast iron. They were then smoothed up on the inside.

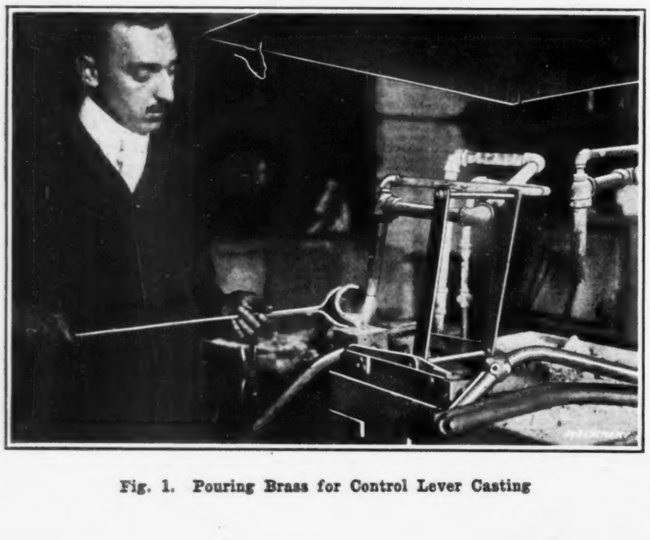

Fig. 1. Pouring Brass for Control Lever Casting

In operation, the movable mold is drawn back by the hand-lever, one of the handle-bar tubings is placed in the mold, and the mold is closed. Following this, the mold is heated to a red heat by the inverted torch shown. The handle-bar tube is also heated to a red heat. Two small crucibles of the type shown are constantly kept in a furnace with just enough molten brass in each crucible for the casting. Two men are generally employed on the operation, and after it is once started, one of the crucibles is heating while the other is being poured. The molten brass is poured through a small hole at the top of the mold.

Cooling takes place almost immediately. The part of the handle-bar tubing which comes directly under the brass casting is previously roughed with a file so that a surface will be afforded for clinging. The machining operations on the castings consist of drilling, counterboring and tapping.

It was in 1912 that this fixture was first made and tried out at the Schickle Motor Co., Stamford, Conn., and it has

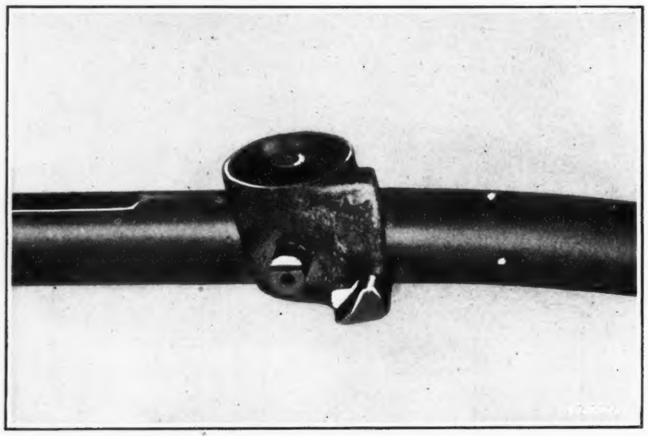

Fig. 2. Machined Casting showing Portion of Handle-bar

been successfully used ever since. Over a period of approximately four ten-hour days, two men have made 360 castings with ease, including the setting up and the removal of all the apparatus.

Applying the casting in this manner gives a firm foundation for the control levers and constitutes a simple way of performing an otherwise difficult job. V. B.

* * *

NATURAL FREQUENCY OF VIBRATION

The Aberthaw Construction Co. of Boston, Mass., has published a pamphlet entitled "The Effect of Vibration on Structures," which is a preliminary report of an extensive investigation carried on by Walter B. Snow for the Aberthaw Construction Co. Reference is made to the natural frequency of vibration of structures as follows:

> Every part of a building—beams, floors, columns, walls, etc., in fact the entire building itself—has its natural pitch of periodic number of vibrations which will result when it is set in motion. If the cause be intermittent and of a different frequency from that of the structural features, the result will be a breaking up of vibrations except for those intervals when they get in step; then the natural action will be exaggerated.
>
> The effect of coincidence between the natural frequency of vibration of a floor and that of its source of disturbance is well illustrated by the following experience in connection with the testing of a small engine upon a floor of timber construction. At a speed of about 550 revolutions per minute, the intensity of the floor vibration was so great that it was impossible to work in the drafting-room located on the same floor more than 100 feet away. But this effect entirely disappeared when the speed was either increased or decreased about 50 revolutions per minute. When the disturbing force is represented by a number of machines running at practically the same speed, the effect may be like that of dancers upon a floor or soldiers marching over a bridge, and prove most destructive to the entire structure or most disordering to its contents or occupants if the step time coincides with its natural pitch.

SPIRAL TYPE BEVEL GEARS[1]

DISCUSSION OF CONDITIONS GOVERNING DESIGN, WITH EXAMPLES TAKEN FROM PRACTICE

BY REGINALD TRAUTSCHOLD[2]

As its name signifies, the spiral type bevel gear has teeth that, instead of being straight as in an ordinary bevel gear, are curved, closely approximating a spiral. To make their production possible on a commercial basis, however, the teeth are generated by rolling the gear blank with a revolving circular face cutter, so that the actual curve of the teeth when developed in a plane is not a true spiral, although it closely approximates such a curve. This is permissible, as there is no particular advantage in securing a true spiral curve, and there would be decided manufacturing difficulties to be overcome if the teeth had to be of exactly this form.

Fig. 1 illustrates a typical lay-out for a pair of spiral type bevel gears, the gear and pinion having a common apex point, so that it is evident that they mesh with a pure rolling action, no sliding taking place between the teeth. The overlapping of the teeth, which is governed by the spiral angle, *i. e.*, the angle between a line tangent to the center line of the curved tooth at its middle point and what would be the corresponding center line of a straight tooth, results in more than one complete tooth being in contact at all times. This promotes quietness and smoothness of operation, the shock of impact common to the straight-tooth bevel gear being avoided. The greater the spiral angle, the more the teeth overlap for a given face width; but there is no advantage, so far as either quietness or smoothness of operation is concerned, in having an excessive overlapping of the teeth; in fact, there is some drawback in too great a spiral angle, for it materially increases the thrust and tends to force the gears out of mesh.

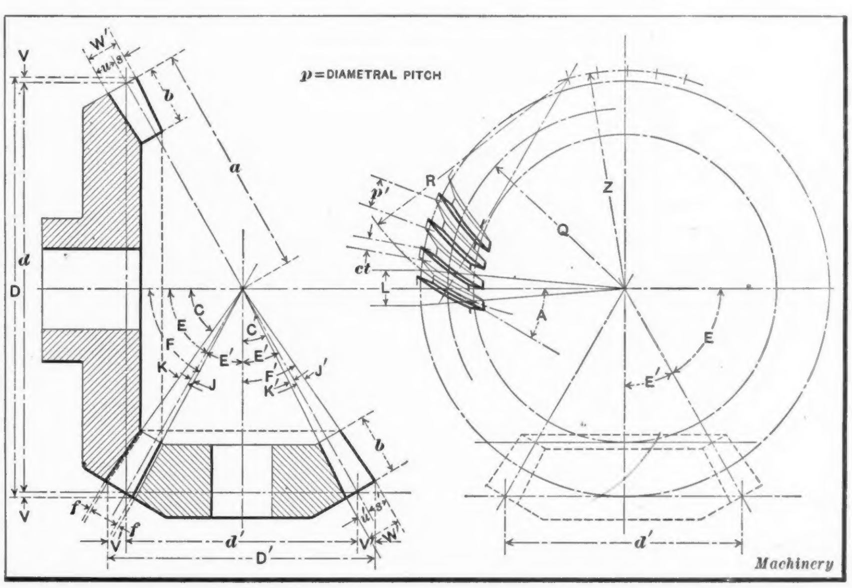

Fig. 1. Typical Lay-out of Spiral Type of Bevel Gears

Direction of Rotation

The direction of rotation is commonly fixed by that of the pinion. Viewing the pinion from the rear, rotation in a clockwise direction is designated as "forward" and in a counter-clockwise direction as "reverse." The rotation of the gear is, of course, in a direction opposite to that of the pinion; and a positive spiral angle is such that the advancing profile plane of the tooth is convex in forward rotation, as illustrated in Fig. 2.

Thrust

The transmitted load is naturally at right angles to the common axis plane, while the total tooth load is normal to the tooth. Considering the tooth pressure as concentrated at the center point of the tooth, arrow A, either above or below the center line of the tooth, according to the direction of rotation, represents the total tooth load; arrow B represents the transmitted load; and arrow C, which is the balancing load in the triangle of forces, represents the thrust either in toward the apex center of the gear or in the opposite direction, according to the direction of rotation. In addition to thrust C, which depends upon the spiral angle, there is the ordinary pressure angle thrust common to all bevel gears. For rotation in one direction, this pressure angle thrust is added to the spiral angle thrust, the combined thrust acting away from the center of the gear; while in the reverse direction, the spiral angle thrust is toward the center of the gear and the pressure angle thrust away from it, so that the resulting thrust is the difference between these two forces.

The pressure angle thrust depends upon several conditions, such as the power transmitted, pitch diameter and pitch angle of pinion, revolutions per minute of pinion, and angle of spiral; but for most practical purposes it may be reduced to a mean percentage of the load transmitted. The spiral angle thrust is, of course, a definite percentage of the transmitted load for a given spiral angle. A chart is shown in Fig. 3, which graphically depicts the average total thrust for spiral angles of from 20 to 40 degrees, the thrust being expressed as a percentage of the transmitted load; it should be noted that plus values indicate pressures away from the gear, and minus values pressures toward the gear apex.

Lead

Obviously, the increased load due to the form of the teeth makes it necessary for either the total tooth load to be carried by more than one tooth or for the teeth to be made wider than would be required for straight-tooth bevel gears. Referring once more to Fig. 2, it will be evident that the total tooth load is equal to the transmitted load divided by the cosine of the spiral angle a. Hence, for a 30-degree spiral angle, for instance, the total tooth pressure would be 15½ per cent greater than the transmitted load, necessitating the use of a tooth 15½ per cent wider than would be required to transmit the same load with a straight tooth; or else overlapping of the teeth must be such that the lead, *i. e.*, the distance measured on the outer pitch circumference, through which tooth contact takes place (see Fig. 2), is equal to 1.155 times the circular pitch, in order to develop a strength equal to a straight-tooth bevel gear of the same pitch and same number of teeth. In other words, the lead measured on the outer pitch circle, as shown at L in Fig. 1, must be greater than the outer circular pitch. Thus, the lead for a 30-degree spiral angle, for instance, must be 1.155 times as great as the outer circular pitch. This should be further increased, the general practice being to make the lead 10 per cent greater than the value just mentioned. In other words, the lead should be such that the teeth in engagement will be 10 per cent stronger than ordinary straight bevel gear teeth of corresponding pitch. The advisable relationship between the spiral angle and tooth load is shown graphically in Fig. 4, the tooth load being expressed as a percentage of the transmitted load. It will be seen that the chart gives values for spiral angles ranging from 20 to 40 degrees; the lower curve gives the total tooth load, while for the upper curve the lead has been adjusted to increase the load carrying capacity of the teeth by 10 per cent.

[1] The Gleason spiral type bevel gear generator was fully described and illustrated in the April, 1914, number of MACHINERY.
[2] Address: 39 Charles St., New York City.

Spiral Angle

The advisable spiral angle is also governed by one other condition, and that is the pitch of the gear, *i. e.*, the finer the pitch the smaller the advisable spiral angle for a given radius of tooth curve. Manufacturing being much simplified by employing cutters of the same diameter for all pitches and all sizes of gears, the hypothesis may safely be accepted that the advisable spiral angle varies directly with the diametral pitch. Good practice in proportioning the spiral angle and pitch is graphically illustrated in Fig. 5. The Gleason Works, Rochester, N. Y., which have developed the spiral type of bevel gear to a high degree of perfection in connection with automobile drives, recommend that the spiral angle should always be made as near 30 degrees as possible. This is unquestionably good practice, but when it is deemed advisable to deviate from this arbitrary rule, the values given in Fig. 5 are recommended.

Minimum Face Width

It is obvious that the amount of lead for a given spiral angle and constant radius of cutter depends upon the face width of the gear. The lead, in turn, is governed by the pitch employed and the power to be transmitted, so, from the point of view of practical design, there is an advisable minimum face width for a given angle of spiral. Using a wider face would permit of making a reduction in the angle of spiral, the radius of the cutter remaining constant; or the radius of the cutter could be increased, the angle of spiral remaining constant. The radius of cutter and the spiral angle being fixed, a greater face width than the minimum requirement for providing the necessary lead places an undue premium on perfection of workmanship and results in no material gain other than an increase in the power capacities of the gears. In the case of spiral type bevel gears, this result can be more advantageously secured by increasing the pitch. That is, the power capacity of a spiral type bevel gear is better regulated by the angle of spiral than by the face width of the gear. On the other hand, the face width must be sufficient to enable the advisable lead to be secured for a given angle of spiral and fixed radius of cutter.

Fig. 6 illustrates the relation between the face width and spiral angle. Angle *efg* is equal to the spiral angle, and dimension L' is equal to the face width of the gear multiplied by the tangent of the angle of spiral. This dimension L' is invariably slightly less than the lead L, *i. e.*, the face width of the gear times the tangent of the spiral angle is slightly less than the lead, so that if the face width were made equal to the lead divided by the tangent of the spiral angle, it would be slightly in excess of what is actually required to secure the desired lead. The excess width would be so slight, however, that it could be safely disregarded, and the advisable minimum face width should be taken as equal to the lead divided by the tangent of the angle of spiral.

Tooth Proportions

The Gleason Works, Rochester, N. Y., to which company must be accorded the credit of developing the spiral type of bevel gear to a marketable and practical point, also build generating machines for cutting the teeth of these gears, and have adopted as the standard tooth one of octoid form with a mean pressure angle of 14½ degrees. The blades of the cutter employed for cutting these teeth are ground to rack form, so that the cutter and gear blank rolling together with a generating motion produce a true octoid tooth. The curved form of the tooth necessitates some slight modification of the standard 14½-degree octoid, however, the pressure angle of the convex side being made slightly greater than 14½ degrees and of the concave side slightly less; but the increase and decrease are equal, so that the sum of the two pressure angles is always 29 degrees.

The spiral type bevel gear enables greater reductions in speed to be employed than can be safely realized with straight-tooth bevel gears, but there is danger of under-cutting the pinion teeth if the addendum is made the customary half of the working depth of the tooth. The standard adopted by the Gleason Works, and one to be recommended, is to make the "pitch depth" of the pinion tooth 7/10 of its total working depth, *i. e.*, the addendum of the pinion tooth 7/10 of the working depth of the tooth; and the "pitch depth" of the gear tooth 3/10 of its working depth, *i. e.*, the addendum of the gear tooth 3/10 of the working depth of the tooth. This modification of long and short addenda naturally affects the face and cutting angles of the gears and also the outside diameters of the gear blanks.

In machining the teeth, two cutters are employed. All teeth are first blocked out with a roughing cutter; a finishing cutter is then substituted, with which one side of each tooth is finished. The finishing cutter is then reset and the other side of the teeth finished. This same cutter is employed for finishing both sides of the teeth, the outer edge of the blades finishing the concave side of the teeth and the inner cutting edge finishing the convex side. Naturally, there is a slight difference in the cutting radii employed for the finishing cuts on the two sides of the teeth, due to the thickness of the cutter blades.

This results in a slight excess of metal being left at the center of each tooth, when the gears are new, and this is an

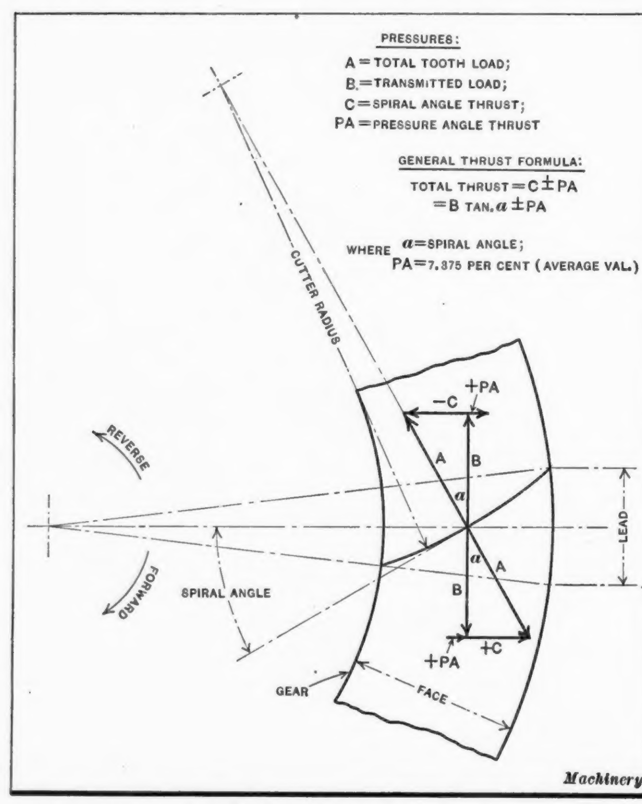

Fig. 2. Diagram of Right-hand Spiral illustrating Lines of Action of Pressures for Forward and Reverse Rotation

advantage rather than a detriment. All gears, but more particularly bevel gears and to an increased extent bevel gears of the spiral type, are subject to a greater vibratory motion due to imperfect surface contact until the contact surfaces of the teeth are worn or ground to a conjugational fit. The wear due to this slight "weave" of parts is therefore concentrated at the center of the teeth of spiral type bevel gears, where the metal is in slight excess, thereby protecting the thinner inner tooth sections. The excess metal is quite rapidly worn away, so that a pair of spiral bevel gears show perfect tooth contact from inner to outer end after but a slight amount of use, the grinding action rapidly perfecting their contact.

Cutter Settings

The horizontal and vertical settings of the roughing cutter center for a right-hand spiral gear are graphically shown in Fig. 7. Measured from the cone apex of the gear, the horizontal setting of the cutter center is equal to the cone distance minus the sum of half the gear face width and the product of the radius of the cutter multiplied by the sine of the spiral angle. The vertical setting equals the radius of the cutter times the cosine of the spiral angle. Fig. 8 depicts the settings required for the finishing cuts. The horizontal setting remains the same, and if it were not for the difference in radii of the cutting edges of the finishing cutter blades, the vertical set-

ting would not have to be altered either, the gear blank simply being revolved backward or forward a distance equal to half the thickness of the tooth. Referring to Fig. 8, ct represents the circular thickness of the tooth on the outer pitch circumference and ct'' the tooth thickness on the inner pitch circumference, points m, n, m', and n' representing intersections with the outer and inner pitch circumferences, respectively. Points m'' and n'' represent the centers of the arcs mm' and nn'. These two centers, together with the point Q, which is the cutter center, lie on the circumference of a circle having the cone apex O as a center, and a radius equal to the square root of the sum of the square of the vertical setting of the roughing cutter and the square of the horizontal setting—see Fig. 8. As on the generating machine, the cutter center may be considered fixed; and the gear blank revolves on the spindle so that points m'' and n'' would both fall on point Q, provided the respective cutting radii were the same as the mean radius of the roughing cutter. Actually the cutting radius for the top side of the tooth, *i. e.*, the concave side as shown, is slightly

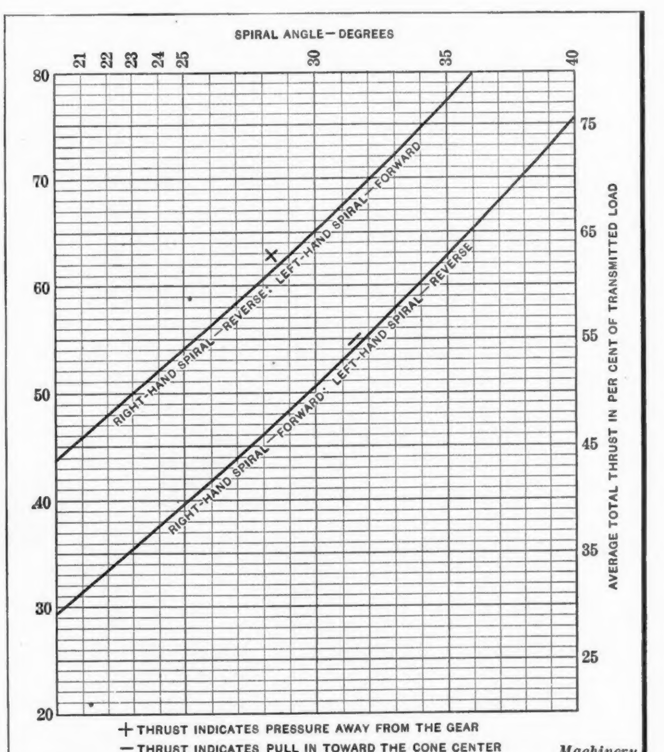

Fig. 3. Chart showing Value and Direction of Thrust developed by Spiral Bevel Gears

greater than the mean radius of the roughing cutter, and the radius of the cutter for the convex side of the tooth slightly less.

In order that gear blank adjustments may be uniform, a very slight variation due to the difference in cutting radii is taken care of by increasing or decreasing the amount of vertical setting, *i. e.*, the cutter center for finishing the concave side of the tooth is moved up to some such point as Q', and the cutter center for finishing the convex side of the tooth dropped to a lower point such as Q'', the ratio of the cutting radii to the corresponding vertical settings remaining constant. The cutter settings as shown in Figs. 7 and 8 are for right-hand gears; and settings for the mating pinions would be similar, but below the horizontal axis plane of the pinion, *i. e.*, the vertical settings X, X' and X'' would be measured below the horizontal line passing through the apex center O. The left-hand gears and pinions would have the position of settings simply reversed; thus, the pinion settings would be above the horizontal axis and the settings for the gear below this axis.

Finishing Cutter

Fig. 9 shows a cross-sectional view of the type of finishing cutter used on the spiral type bevel gear generator built by the Gleason Works. Outside cutter angle T is slightly less than 14½ degrees and finishes the concave side of the tooth, while the inner cutter angle B, which is a corresponding amount greater than 14½ degrees, finishes the convex side of the tooth. The respective angles T and B for cutters 12 inches in diameter, which is the Gleason Works' standard, for gears having addendum equal to 3/10 the working depth and the pinion addendum 7/10 the working depth, have been carefully worked out by that company, and the values which give good results are plotted on the chart shown in Fig. 10. The Gleason Works base their choice of finishing cutter angles upon the spiral angle of the gear; but, as the same cutter may be used for various pitches within a certain range, it seems simpler to base the choice of a cutter angle upon the diametral pitch employed, irrespective of the spiral angle, the spiral angle being about the minimum that will enable the desired lead to be secured for a given face width of gear and definite cutter diameter.

Notations for Spiral Type Bevel Gears

Design and General	Gear	Pinion
Diametral pitch	p	p
Circular pitch	p'	p'
Number of teeth	n	n'
Spiral angle	A	A
Lead	L	L
Face width, actual	b	b
Face width, minimum	b'	b'
Depth of tooth	W'	W'
Addendum	s	s'
Dedendum	u	u'
Clearance	f	f
Circular thickness of tooth on outer pitch circumference	ct	ct'
Center angle	E	E'
Pitch diameter	d	d'
Cone distance	a	a
Angle increment	J	J'
Angle decrement	K	K'
Face angle	F	F'
Cutter angle	C	C'
Diameter increment	V	V'
Outside diameter	D	D'
Shop		
Diameter of cutter	D''	D''
Radius of cutter (mean)	R	R
Inner cutter angle	B	B
Outer cutter angle	T	T
Thickness of cutter at apex	t''	t''
Horizontal setting	Y	Y
Vertical setting (roughing cut)	X	X
Vertical setting (finishing cuts):		
Top side of tooth (concave)	X'	X'
Bottom side of tooth (convex)	X''	X''

Formulas for Spiral Type Bevel Gears

Test formula:

$$b' = \frac{L}{\tan A} \quad \text{or, advisably, } \tan A = \frac{L}{b} \qquad \text{(A)}$$

Design calculations:

$$\operatorname{Tan} E = \frac{n}{n'} \quad (1) \qquad E' = 90 - E \quad (1a)$$

$$d = \frac{n}{p} \quad (2) \qquad d' = \frac{n'}{p} \quad (2a)$$

$$W' = \frac{2.157}{p} \ (14\tfrac{1}{2}\text{-degree standard tooth}) \quad (3)$$

$$s = \frac{\text{pitch depth} \times 2}{p} = \frac{0.6}{p} \quad (4) \qquad s' = \frac{\text{pitch depth} \times 2}{p} = \frac{1.4}{p} \quad (4a)$$

$$u = W' - s \quad (5) \qquad u' = W' - s' \quad (5a)$$

$$ct = 0.5p' - \frac{0.2069}{p} \ (14\tfrac{1}{2}\text{-degree standard tooth}) \quad (6)$$

$$ct' = 0.5p' + \frac{0.2069}{p} \ (14\tfrac{1}{2}\text{-degree standard tooth}) \quad (6a)$$

$$a = \frac{0.5d}{\sin E} = \frac{0.5d'}{\sin E'} \quad (7)$$

$$\operatorname{Tan} J = \frac{s}{a} \quad (8) \qquad \operatorname{Tan} J' = \frac{s'}{a} \quad (8a)$$

$$\operatorname{Tan} K = \frac{u}{a} \quad (9) \qquad \operatorname{Tan} K' = \frac{u'}{a} \quad (9a)$$

$$F = E + J \quad (10) \qquad F' = E' + J' \quad (10a)$$

$$C = E - K \quad (11) \qquad C' = E' - K' \quad (11a)$$

$$V = s \cos E \quad (12) \qquad V' = s' \cos E' \quad (12a)$$

$$D = d + 2V \quad (13) \qquad D' = d' + 2V' \quad (13a)$$

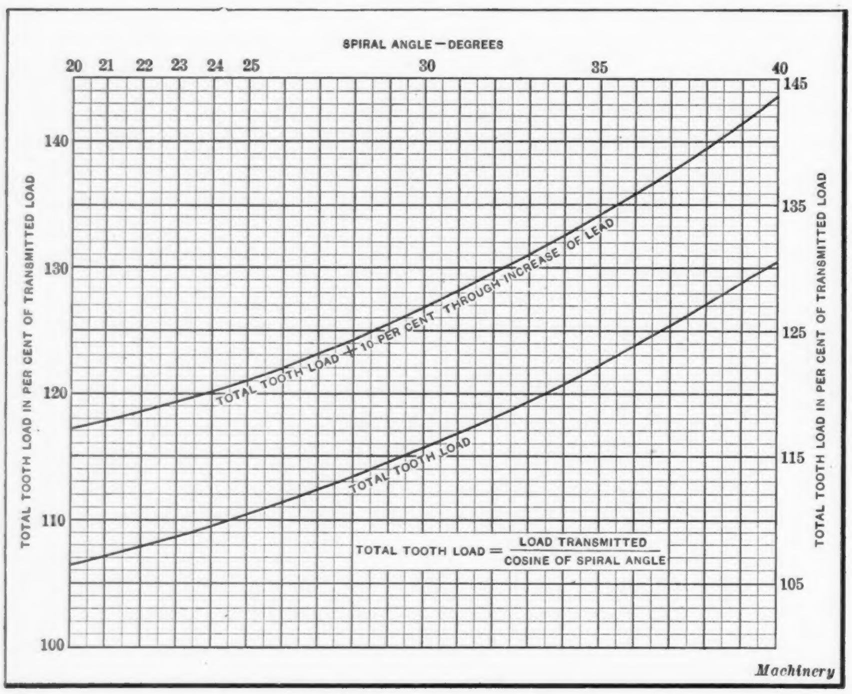

Fig. 4. Chart showing Advisable Relationship between Spiral Angle and Total Tooth Load as Percentage of Transmitted Load for Spiral Angles from 20 to 40 Degrees

Notations for Shop Calculations

	Gear	Pinion
Outer cutting radius (concave side—mean value)..	R'	R'_p
Inner cutting radius (convex side—mean value)..	R''	R''_p
Dedendum at mid-tooth..........................	u''	u''_p

All other notations similar to those employed for design calculations.

Formulas for Shop Use

$$u'' = \frac{(a - 0.5b)u}{a} \quad \text{(I)} \qquad u''_p = \frac{(a - 0.5b)u'}{a} \quad \text{(IA)}$$

$$R' = R + 0.5(t'' + 0.5172u'') \quad \text{(II)}$$

$$R'_p = R + 0.5(t'' + 0.5172u''_p) \quad \text{(IIA)}$$

$$R'' = R - 0.5(t'' + 0.5172u'') \quad \text{(III)}$$

$$R''_p = R - 0.5(t'' + 0.5172u''_p) \quad \text{(IIIA)}$$

$$Y = a - (0.5b + R \sin A) \quad \text{(IV)}$$

$$X = R \cos A \quad \text{(V)} \qquad X' = \frac{R'X}{R} \quad \text{(VI)} \qquad X'_p = \frac{R'_pX}{R} \quad \text{(VIA)}$$

$$X'' = \frac{R''X}{R} \quad \text{(VII)} \qquad X''_p = \frac{R''_pX}{R} \quad \text{(VIIA)}$$

Derivation of Foregoing Formulas

All formulas of tooth proportions, pitch diameters, center angles, etc., which are not affected by the "pitch depth" of the gear or pinion, are derived in a manner similar to that for equivalent formulas for straight-tooth bevel gears.

The working depth of any standard 14½-degree tooth is equal to 2 divided by the diametral pitch, so the addendums of the gear and pinion are found by multiplying $\frac{2}{p}$ by the proportion of working depth represented by the respective addendums, *i. e.*, multiplying $\frac{2}{p}$ by the proportional "pitch depth." For gears in which the pitch depth equals 0.3 of the working depth of the tooth, this is equal to 0.6 divided by the diametral pitch; and for pinions in which the pitch depth equals 0.7 of the working depth of the tooth, it equals 1.4 divided by the diametral pitch.

The dedendum is most readily figured by subtracting the addendum from the working depth of the tooth, the latter being the same as in the case of ordinary straight-tooth bevel gears.

The circular thickness of tooth on the pitch circumference of the gear is equal to half the circular pitch minus twice the product of the tangent of the pressure angle by the difference between the pitch depth and half the working depth of the tooth, divided by the diametral pitch. The circular thickness of the tooth on the pitch circumference of the pinion is equal to half the circular pitch plus the same amount.

The cone distance of spiral type bevel gears is the same as that for ordinary bevel gears; but the angle increment J and decrement K are affected by the pitch depth of the gear and pinion, their tangents being, respectively, the addendums and the dedendums, divided by the cone distance.

The face and cutting angles of the gear and pinion are simply affected by the change in angle increment and decrement, the formulas being similar to those for straight bevel gears; and the same is true of the diameter increments and outside diameters of the gear and pinion.

The finishing cutter radii must necessarily be proportioned to the bottom width of the tooth spaces, necessitating taking into consideration the relative position of the pitch line, *i. e.*, the pitch depth of gear and pinion. The outer cutting radius for the concave side of the tooth is equal to the mean cutter radius plus one-half the sum of the apex thickness of the cutter plus the dedendum (at the center point of the tooth) times the tangent of the outside cutter angle. The inner cutting radius is equal to the mean cutter radius minus one-half the sum of the apex thickness of the cutter and the product of the mean dedendum multiplied by the tangent of the inner cutter angle.

The method of making the horizontal and vertical settings of the cutter for taking both roughing and finishing cuts has already been explained, but it must always be borne in mind that these formulas presented for the finishing cut settings are based on respective cutting radii normal to the pitch planes at the center point of the tooth profiles, and not at either the outer or inner pitch circumference. The finishing cutter radius (for either side of the tooth) varies from outer to inner end of tooth, but by locating the vertical setting from the cutting radius at mid-tooth, the angle decrement automatically causes the required variation in radius on the pitch plane and over the entire tooth profile.

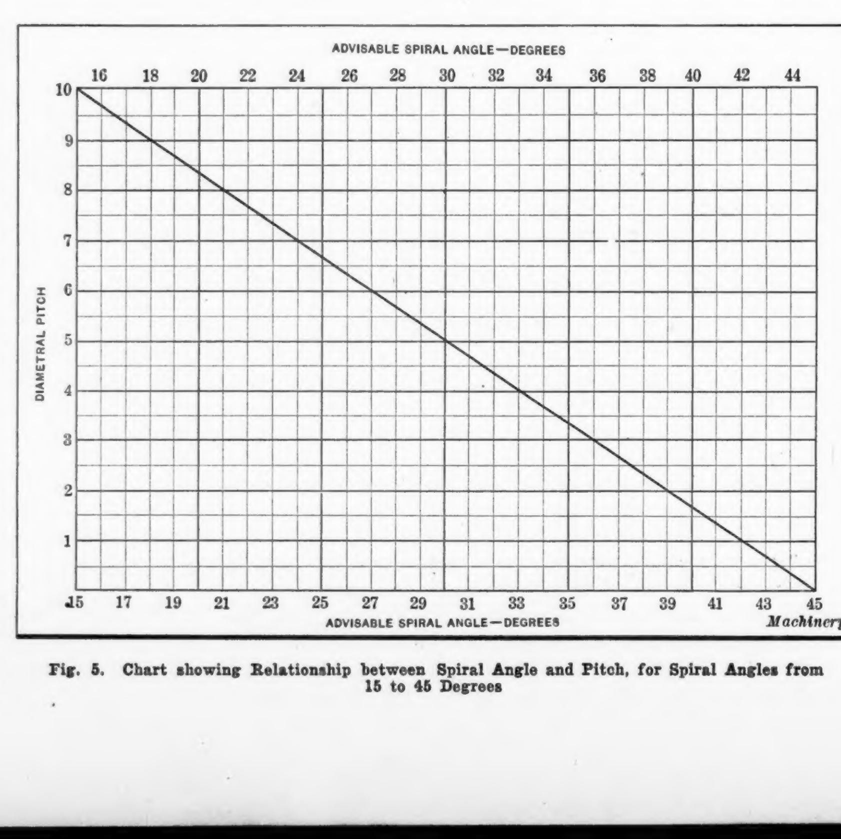

Fig. 5. Chart showing Relationship between Spiral Angle and Pitch, for Spiral Angles from 15 to 45 Degrees

Lay-out Method

The Gleason Works employ a lay-out method for ascertaining the required vertical settings for the finishing cuts, instead of the formula method herein described. The tooth profiles are laid out on an enlarged scale and the required dimensions accurately scaled. This method of obtaining the vertical settings for the finishing cuts is based on a somewhat different theory than that governing the formula method, and as its advocates claim that greater precision results from its use, a brief description of this method may be of interest.

Referring to Fig. 11, it will be seen that a diagram of the gear is laid out on an enlarged scale, in which the curve lm represents the center line of the tooth, the curve being the arc of a circle having its center located by the horizontal and vertical settings for the roughing cut and a radius equal to the mean radius of the cutter. For the top (concave) side of the tooth, points l' and m' are struck off from points l and m, respectively, on the radii to these points, *i. e.*, on lines radiating from the cutter center to the points of intersection of the center line of the tooth with the inner and outer pitch circumferences. Distances ll' and mm' equal the dedendum times the tangent of the pressure angle at the respective points. The ratio ll' to mm' is equal to ratio a to $(a - b)$. With the points l' and m' as centers and a radius equal to the mean radius of the cutter plus one-half the thickness of the cutter blade at its apex, arcs are struck off intersecting at Q'.

For the bottom (convex) side of the tooth, similar steps are taken to locate point Q'', using a radius equal to the mean radius of the cutter minus one-half the thickness of the cutter blade at its apex, from points l'' and m'', the latter points being located by a similar procedure to that employed for finding points l' and m'.

Finally, with O as a center, arcs are struck through points Q' and Q'' to the plane of vertical settings, and the respective vertical settings X' and X'' carefully scaled. The vertical settings thus secured differ from those obtained by the formula method, as the three points Q, Q' and Q'' do not lie on the arc of a circle having point O as a center. In some cases—for instance, on the lay-out shown in Fig. 11—the vertical setting for the convex side of the tooth may be greater than that for the concave side when the settings are obtained by the lay-out method, which would never occur with the formula method.

Comparison of Methods

The relative accuracy of the two methods is open to argument. Two sides of the teeth being finished with slightly different cutter radii, there can actually be but one point of perfect tooth contact, but for all practical purposes contact takes place over quite an appreciable length of tooth, even before the gears have been run together and worn into perfect mesh, as the difference in the heights of the respective arcs—that of the concave side and that of the convex side of meshing teeth—is extremely slight. In gears finished on vertical settings arrived at by the formula method, the point of perfect contact is located on both convex and concave profiles at the same relative point, *i. e.*, on the mid-pitch circumference where the curved profiles of the teeth are tangent to the spiral angle plane. In gears finished on vertical settings arrived at by the lay-out method, the point of tangency between the spiral angle plane and the tooth profile is not located at the same relative point on both the concave and convex profiles, the points of tangency depending upon the relation of the horizontal setting to the vertical settings, the angle of spiral, etc., as shown in Fig. 12.

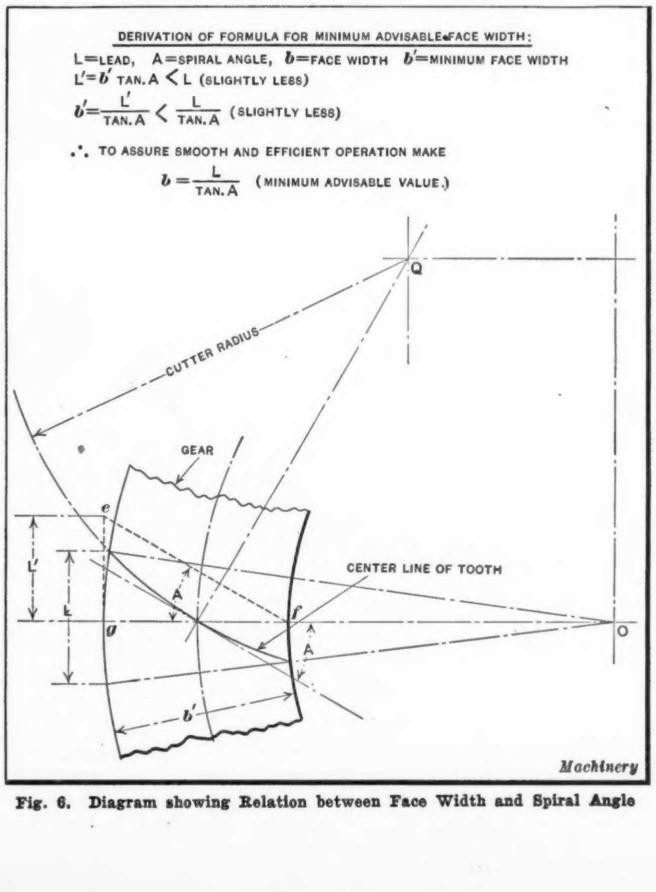

Fig. 6. Diagram showing Relation between Face Width and Spiral Angle

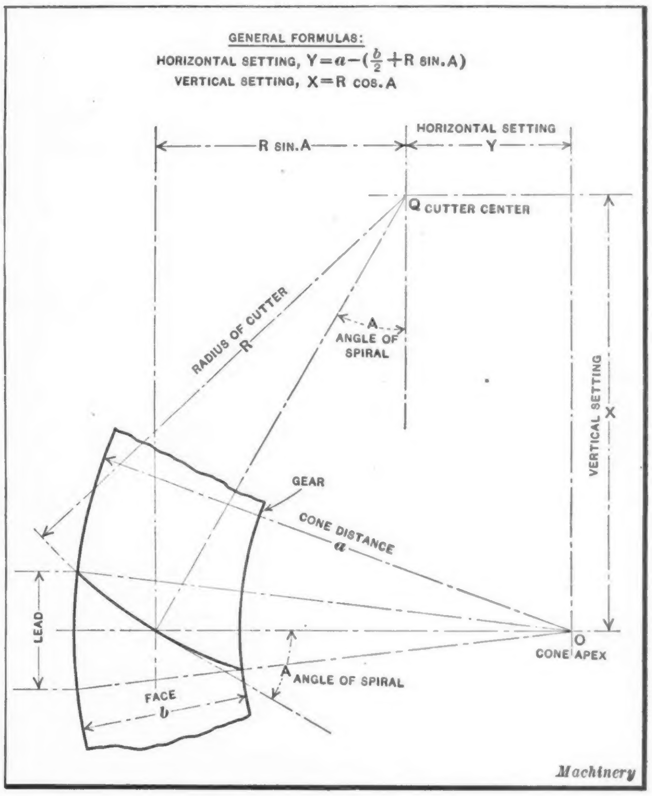

Fig. 7. Horizontal and Vertical Settings for Roughing Cutter Center for Right-hand Spiral Gear

When the more remote point of tangency is on the convex profile, as depicted in Fig. 12, this failure of the spiral angle plane to be tangent to both sides of the tooth at the same relative point is actually a slight advantage, as it locates the point of contact at a place where the power transmitted is slightly greater than at mid-tooth and where the tooth is slightly heavier. In cases where the contact point on the convex profile is slightly nearer the inner edge of the gear than mid-tooth, no appreciable disadvantage exists on account of the flatness of the contact arcs. The slight eccentricity given to the load on the teeth by failure of the spiral angle plane to be tangent at corresponding points on both sides of the tooth, tends to accelerate the slight weave of parts which produces the perfect tooth contact of spiral type bevel gears which have been run together.

The lay-out method is open to the possibility of error in scaling and laying out the diagram, and, in addition, it takes considerably more time than is required to make the simple calculations involved in using the formula method. This excess time could be put to far better advantage in running the gears together to perfect tooth contact—at least, the time saved by the formula method would compensate for the longer time required in truing up the tooth contact of gears generated on vertical settings derived from the formulas. Both methods of arriving at the vertical settings for the finishing cuts have their advocates, so that the choice of methods is almost en-

tirely a matter of personal preference on the part of the manufacturer or machinist.

Spiral Bevel Gear Design

Example:—Required, a pair of spiral bevel gears, 5 diametral pitch, 75 teeth in gear, 25 teeth in pinion, 1½ inch face width.

General Calculations

Circular pitch:

$$p' = \frac{3.1416}{5} = 0.6283 \text{ inch}$$

The lead should be 1.269 times the circular pitch, as shown in Fig. 4; hence:

$$L = 1.269 \times 0.6283 = 0.7970 \text{ inch}$$

Spiral angle:

$$\text{Tan } A = \frac{0.7970}{1.5} = 0.5313 \quad \text{(A)} \quad A = 27 \text{ degrees, } 59 \text{ minutes}$$

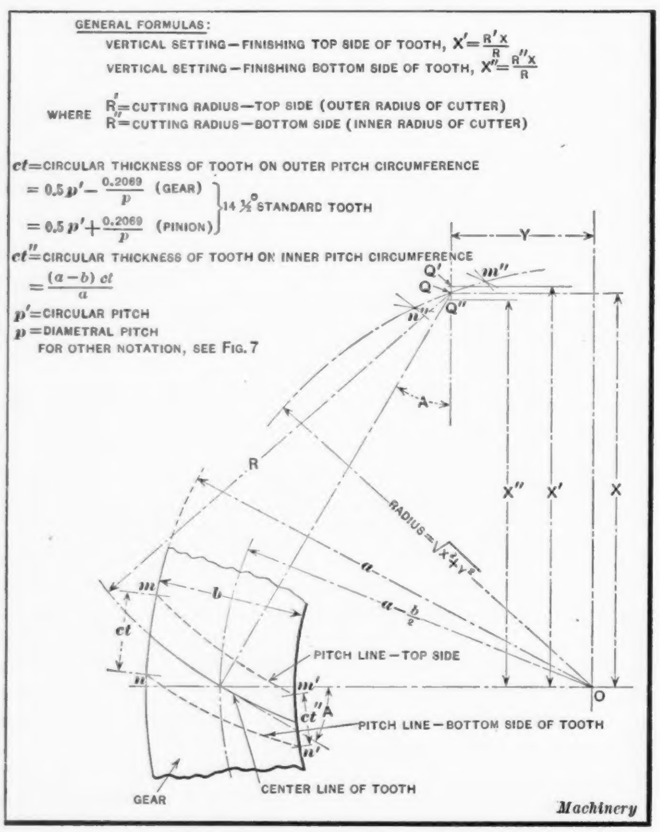

Fig. 8. Vertical Settings for Finishing Cutter for Right-hand Spiral Gear

Design Calculations

Center angles:

$$\text{Tan } E = \frac{75}{25} = 3.0000 \quad (1) \quad E = 71 \text{ degrees, } 34 \text{ minutes}$$

$$E' = 90 - 71 \text{ degrees, } 34 \text{ minutes} = 18 \text{ degrees, } 26 \text{ minutes} \quad (1a)$$

Pitch diameters:

$$d = \frac{75}{5} = 15 \text{ inches} \quad (2) \qquad d' = \frac{25}{5} = 5 \text{ inches} \quad (2a)$$

Depth of tooth:

$$W' = \frac{2.157}{5} = 0.4314 \text{ inch} \quad (3)$$

Addendums:

$$s = \frac{0.6}{5} = 0.12 \text{ inch} \quad (4) \qquad s' = \frac{1.4}{5} = 0.28 \text{ inch} \quad (4a)$$

Dedendums:

$$u = 0.4314 - 0.12 = 0.3114 \text{ inch} \quad (5)$$
$$u' = 0.4314 - 0.28 = 0.1514 \text{ inch} \quad (5a)$$

Circular thickness of tooth on pitch circumferences:

$$ct = 0.5 \times 0.6283 - \frac{0.2069}{5} = 0.2728 \text{ inch} \quad (6)$$

$$ct' = 0.5 \times 0.6283 + \frac{0.2069}{5} = 0.3555 \text{ inch} \quad (6a)$$

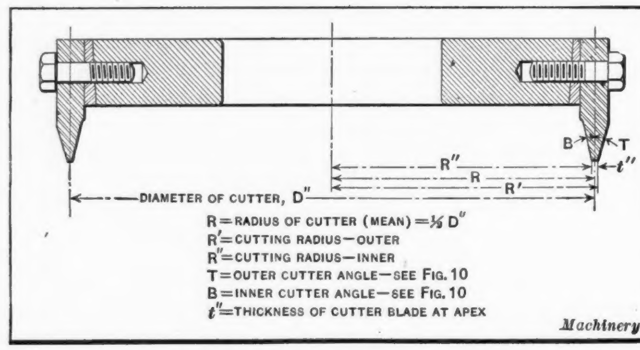

Fig. 9. Cross-sectional View of Finishing Cutter used on Gleason Spiral Bevel Gear Generator

Cone distance:

$$a = \frac{0.5 \times 15}{0.948690} = \frac{0.5 \times 5}{0.31623} = 7.9070 \text{ inches} \quad (7)$$

Angle increments:

$$\text{Tan } J = \frac{0.12}{7.9070} = 0.01518 \quad (8) \quad J = 0 \text{ degrees, } 52 \text{ minutes}$$

$$\text{Tan } J' = \frac{0.28}{7.9070} = 0.03542 \quad (8a) \quad J' = 2 \text{ degrees, } 2 \text{ minutes}$$

Angle decrements:

$$\text{Tan } K = \frac{0.3114}{7.9070} = 0.03938 \quad (9) \quad K = 2 \text{ degrees, } 15 \text{ minutes}$$

$$\text{Tan } K' = \frac{0.1514}{7.9070} = 0.01915 \quad (9a) \quad K' = 1 \text{ degree, } 6 \text{ minutes}$$

Face angles:

$$F = 71 \text{ deg., } 34 \text{ min.} + 0 \text{ deg., } 52 \text{ min.} = 72 \text{ deg., } 26 \text{ min.} \quad (10)$$
$$F' = 18 \text{ deg., } 26 \text{ min.} + 2 \text{ deg., } 2 \text{ min.} = 20 \text{ deg., } 28 \text{ min.} \quad (10a)$$

Cutting angles:

$$C = 71 \text{ deg., } 34 \text{ min.} - 2 \text{ deg., } 15 \text{ min.} = 69 \text{ deg., } 19 \text{ min.} \quad (11)$$
$$C' = 18 \text{ deg., } 26 \text{ min.} - 1 \text{ deg., } 6 \text{ min.} = 17 \text{ deg., } 20 \text{ min.} \quad (11a)$$

Diameter increments:

$$V = 0.12 \times 0.3162 = 0.03794 \text{ inch} \quad (12)$$
$$V' = 0.28 \times 0.9486 = 0.26561 \text{ inch} \quad (12a)$$

Outside diameters:

$$D = 15 + 2 \times 0.03794 = 15.0759 \text{ inches} \quad (13)$$
$$D' = 5 + 2 \times 0.26561 = 5.5312 \text{ inches} \quad (13a)$$

Shop Calculations

$R = 6$ inches (Arbitrary)

$t'' = 1/16$ inch (Arbitrary)

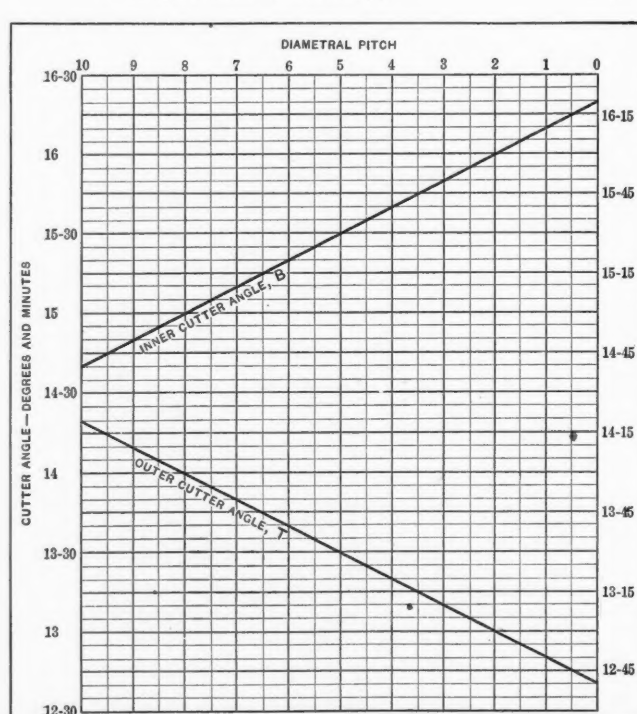

Fig. 10. Chart showing Suitable Angles for Finishing Cutter, for Gears of Various Diametral Pitches

$T = 13$ degrees, 30 minutes (Chart, Fig. 10)
$B = 15$ degrees, 30 minutes (Chart, Fig. 10)

Dedendum at mid-tooth:

$$u'' = \frac{(7.907 - 0.5 \times 1.5)0.3114}{7.907} = 0.2830 \text{ inch} \qquad \text{(I)}$$

$$u''_p = \frac{(7.907 - 0.5 \times 1.5)0.1514}{7.907} = 0.1370 \text{ inch} \qquad \text{(IA)}$$

Outer cutting radius (mean)—finishing cutter:

$$R' = 6 + 0.5(0.0625 + 0.5172 \times 0.283) = 6.1044 \text{ inches} \qquad \text{(II)}$$

$$R'_p = 6 + 0.5(0.0625 + 0.5172 \times 0.137) = 6.0667 \text{ inches} \qquad \text{(IIA)}$$

Inner cutting radius (mean)—finishing cutter:

$$R'' = 6 - 0.5(0.0625 + 0.5172 \times 0.283) = 5.8956 \text{ inches} \qquad \text{(III)}$$

$$R''_p = 6 - 0.5(0.0625 + 0.5172 \times 0.137) = 5.9333 \text{ inches} \qquad \text{(IIIA)}$$

Horizontal setting:

$$Y = 7.907 - (0.5 \times 1.5 + 6 \times 0.4692) = 4.3418 \text{ inches} \qquad \text{(IV)}$$

Vertical setting (roughing cut):

$$X = 6 \times 0.8831 = 5.2986 \text{ inches} \qquad \text{(V)}$$

Vertical settings (finishing cuts):

$$X' = \frac{6.1044 \times 5.2986}{6} = 5.3906 \text{ inches} \qquad \text{(VI)}$$

$$X'_p = \frac{6.0667 \times 5.2986}{6} = 5.3575 \text{ inches} \qquad \text{(VIA)}$$

$$X'' = \frac{5.8956 \times 5.2986}{6} = 5.2064 \text{ inches} \qquad \text{(VII)}$$

$$X''_p = \frac{5.9333 \times 5.2986}{6} = 5.2397 \text{ inches} \qquad \text{(VIIA)}$$

In the example just carried out to explain the design of spiral bevel gears, the angle of spiral, in order that the gear may possess smooth and silent operation, is based upon the face width of the gear. The angle worked out to 27 degrees, 59 minutes, which might be inconvenient if the gears were made up in quantities and it were desired to stock them according to some classification. The recommended angle of spiral based on the pitch of the gear—shown on the chart in Fig. 5—would be 30 degrees, which if used would give a lead slightly greater than necessary, but this would have little or no effect upon the efficiency of the gearing or upon the amount of machining required. There might possibly be a slight increase in time required for cutting the gears on account of the slightly greater length of tooth, but this would be of little moment, and if there is anything to be gained in the way of standardization by adopting a standard angle of spiral, such as 30 degrees, it may safely be done.

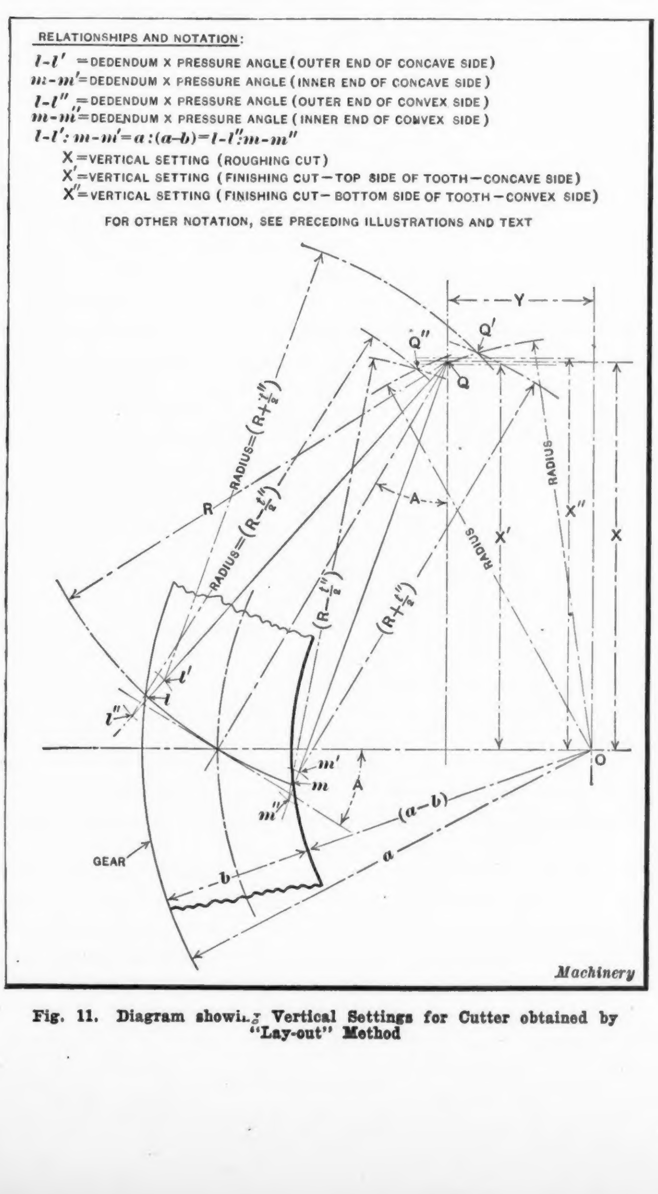

Fig. 11. Diagram showing Vertical Settings for Cutter obtained by "Lay-out" Method

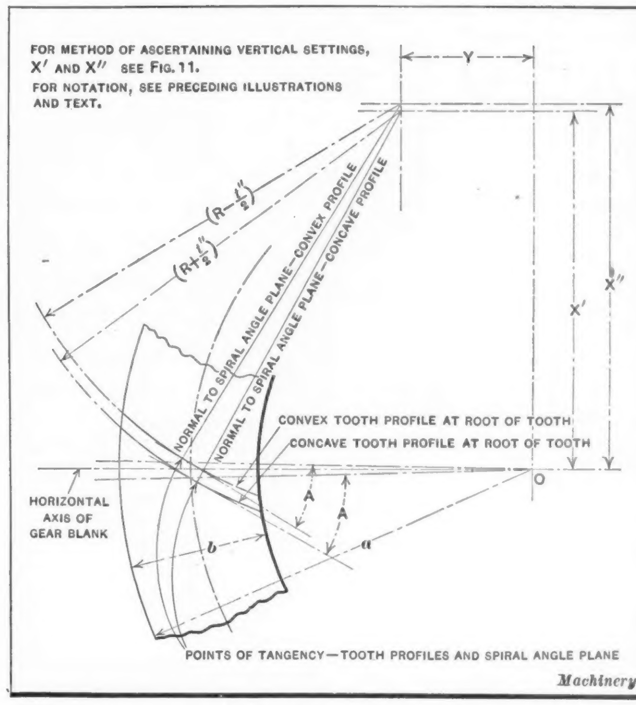

Fig. 12. Diagram showing Tooth Contact secured when Cutter is located by "Lay-out" Method

Efficiency

The efficiency of spiral bevel gears does not vary to any extent from that of equivalent accurately cut straight-tooth bevels. Increased thrust tending to reduce efficiency can be easily cared for by suitable bearing design, thus greatly discounting any loss due to the greater total tooth pressure. Even should the thrust cause a slight disarrangement in the perfection of meshing, such disarrangement is not nearly as harmful in spiral bevel gears as it is in the straight type. In fact, endwise adjustment of the pinion double that which would be the limit for straight-tooth bevel gears produces no appreciable loss in efficiency—at least, none perceptible by reason of noise in operation. That is, a pair of spiral bevel gears will run practically noiselessly, even when the endwise adjustment of the pinion is so marked that if similar maladjustment of straight-tooth bevel gears should occur, they would be exceedingly noisy in operation and inefficient.

The pure rolling tooth contact of spiral bevel gears not only avoids the annoying shock of impact common to the majority of straight-tooth bevel gears, but at the same time insures a high degree of efficiency. The average well cut spiral bevel gear is at least as efficient as the highest grade of straight-tooth bevel gear, and the greater speed ratio attainable by the use of curved teeth makes these gears of particular advantage and value in automobile drives, for which service they were originally developed. Spiral bevel gears are suitable for any class of service for which straight-tooth bevel gears are successfully employed, and they will generally operate at higher efficiency and give better satisfaction.

* * *

According to the *Iron Age*, the Russian imports of certain steel products for 1915, over the European, Russo-Finnish and Black Sea frontiers, amounted to 76,660 metric tons. In 1913, these imports amounted to 54,770 metric tons; and in 1914, 41,230 metric tons. The increase for 1915 over 1914 is due mostly to imports of barb wire, for the imports of wire and manufactures increased from 7490 to 48,660 metric tons.

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LIMIT, ALLOWANCE AND TOLERANCE

There seems to be general misunderstanding among mechanical men of the meaning and application of the terms "limit," "allowance" and "tolerance" when used with reference to interchangeable manufacturing. We make the assertion advisedly because of the fact that the terms are used loosely and interchangeably. This confusion of terms shows that a clear understanding of the principles of interchangeability and gaging is wanting, and is most unfortunate, because the efficiency of any system of gaging and inspection depends to a large degree on the clearness of understanding of those who are responsible for fixing limits and inspection methods.

The term "limit" when used in interchangeable manufacture means something fixed beyond which it is not permissible to go; it might be likened to one jaw of a gage itself—it is a point beyond which the dimension of a piece must not extend. Thus if the nominal dimension of a piece is one inch, a limit of over-size may be fixed at 0.001 inch, and hence the "Go" limit gage would measure 1.001 inch. Any size larger than this cannot be passed, because it "goes beyond the limit." On the other hand, it is customary to pass parts that are slightly smaller than the nominal size. If the minus limit is 0.001 inch, then the "Not Go" gage will measure 0.999 inch. Thus the actual variation of size or tolerance is 0.002 inch.

An "allowance" is an amount arbitrarily fixed by the designer for the kind of fit wanted. If he is providing for a running fit, a certain difference between the sizes of the internal and external members will be made; if it is a push fit, the difference or allowance will be less; if it is a press fit, it will be negative, that is, the shaft will be made larger than the bore of the part into which it is to be forced.

"Tolerance" is the variation allowed in order to provide for the difficulties of manufacture and the practical impossibility of making any part to an exact dimension. A working tolerance is fixed by considerations of the grade of work required, characteristics of the material, skill of the operator and the accuracy of machine tools. The difference in the dimensions of the "Go" and "Not Go" ends of a gage is the tolerance. Hence, the limits fixed must include the tolerance or allowable variation from the mean dimension and the allowance for the character of fit required. Limits and allowances are arbitrarily fixed, while tolerances are variations permitted because they cannot be prevented.

METHODS OF DIMENSIONING DRAWINGS

Delay and unnecessary expense are sometimes caused in manufacturing by improper methods of dimensioning drawings. Drawings that are improperly dimensioned are a source of confusion both to the draftsman who checks them up and to the workman who is responsible for making the parts to the specified dimensions. In the dimensioning of a shouldered shaft, for instance, it is general practice to give the distance between each shoulder on the shaft, and then set the manufacturing limits of tolerance above and below this dimension. The difficulty of checking up a drawing so dimensioned is obvious, and the time required to make the shaft to the dimensions given, and hold the total length to within reasonable limits, is greater than it should be. The proper way of dimensioning a shouldered shaft is to take all the measurements from one point. For instance, if there is one shoulder on the shaft that fits against a frame in the machine or must bear a certain relation to some other part, then the dimensions should all read from this shoulder and in one direction. Thus checking up the drawing is simplified, and the workman is enabled to work much more rapidly in taking off dimensions.

Another matter that receives too little attention in the drafting-room is the method of setting limits on drawings. The usual practice is to give either the largest and smallest dimensions in common fractions or thousandths of an inch, or to give the nominal dimensions and then give the limits above and below. The difficulty of checking up a drawing so dimensioned is only too well known; many serious errors have resulted from the practice. A better way is to give all the limits on one side of the nominal dimension. In so doing the tolerance on any number of parts that go together to make a unit can be found by simple addition. Furthermore, it can be seen at a glance how much the total tolerance is.

The objection will be raised to this method that it eliminates the use of standard reamers, because of the necessity in some cases of having a hole larger than a standard size reamer. The number of "standard" reamers in use is small, however, as compared with special reamers, and if a reamer is made special, it is as easy to make it 0.0005 inch above 1 inch, so that it will produce a hole greater than 1 inch, as it is to make it exactly 1.000 inch. The limits can then be given on the hole above the nominal size.

* * *

LIMITATIONS OF HIGH-SPEED STEEL

High-speed steel has wrought a revolution in machine shop practice. Speeds and feeds undreamed of in the days of carbon tool steel exclusively are now commonplace. The red hardness characteristic of high-speed steel, that is, the quality of being harder at a temperature of 1400 to 1500 degrees F. than when cold, enables it to stand up under conditions that quickly destroy the best carbon steel tools. All this is generally known, but there seems to be a widespread misconception of the advantages of using high-speed steel for chisels, dies and tools not used to cut at high speed. The fact that high-speed steel has shown such wonderful improvement in efficiency over carbon steel for turning, planing, milling and other machining operations is no indication whatever that it is superior for many other purposes. The fact is high-speed steel is decidedly inferior to carbon steel for many purposes. High-speed steel is softer than carbon steel when cold, and therefore is not as well suited for purposes where great strength, hardness and wearing quality are required at ordinary temperatures.

The limitation of high-speed steel, and, in fact, its inferiority to carbon steel for many purposes, is only one more example of the need of exercising common sense and judgment in the use of materials. Because a material is scarce and high priced is not necessarily evidence that it is best for a given purpose. The designer should strive always to use the material best suited to the purpose intended, no matter whether the cost is much or little. Of course, there are materials so costly that it is out of the question to use them for certain purposes; but, on the other hand, the designer should never be afraid to use a cheap material if he is convinced that it is superior to a more costly one.

ORIGINATION VERSUS IMITATION IN DESIGN

BY R. H. McMINN[1]

The writer received his first instruction in mechanical drawing from a man employed as designer by a large manufacturer. This teacher's answer to the question as to how a person could most easily become a successful designer was, "Imitate other designs." The thought of being obliged to become an imitator was quite disappointing, so he secretly resolved not to follow this counsel. Later, when attending a technical college, the writer thought that when he entered upon commercial work he would be able, using the fundamental principles, to develop with great freedom new mechanisms for any desired end. During nine or ten years of practical experience, however, he has had cause to modify some of his early views.

Given the task of designing a machine to accomplish a certain result, an early reluctance to study and imitate known designs of that class of machines was partly due to a desire to accomplish the same result by means not used before because of the personal satisfaction which comes from originating. It was also due to a sort of sentimental disinclination to willfully copy the work of others as closely as is legally allowable. This attitude was perhaps rather inconsistent in view of the fact that everything learned up to that time was the result of other's work—all by instruction or from books; nothing by original investigation in new fields. But he had pictured the work of the mechanical engineer to be, for the most part, that of an inventor, and thought that to study and try to remember the maximum possible number of mechanisms used in various fields would operate against the cultivation of the inventive instinct.

Because of such opinions the writer failed to study books and current technical literature at the time when a man is perhaps best fitted to get the most out of reading with the least expenditure of energy—that is, when just out of school, for he has then a more intimate knowledge of mathematics than he will ever have again. A great many engineering graduates make the same mistake by thinking they are through with books and assuming that their main advancement thenceforth will come automatically from practical experience. But just at this time a varied reading of technical literature, properly chosen, can greatly increase a person's rate of advancement; for it is largely the lack of knowledge of minute details of design and manufacture which causes men fresh from school to be considered inexperienced. For this reason, technical schools should use text-books which are thoroughly up-to-date, so that the student may be drilled in the fact that he is studying not only principles but their embodiment in examples of the best American practice down to the smallest details.

One learns in a technical school the fundamental principles of chemistry, physics, mechanics, mathematics, and drawing, but becomes acquainted in a comparatively small degree with the practical application of these sciences to machine parts. When later the graduate is required to design a machine to accomplish a certain result, he must, if working independently, choose between the alternatives of using only his knowledge of basic principles and the few machine elements with which he is acquainted as the basis for design, or of finding out what others have done in some similar machine.

Theoretically, perhaps, the fewer machine details with which the inexperienced man is familiar, the wider opportunity there is for developing his resourcefulness in design. But when a person enters commercial work, the cultivation of his ingenuity must be incidental to his main activities. It takes more time and money to develop devices when one starts with a knowledge of a comparatively few simple mechanical forms, so that financial considerations demand that one learn as many as possible of the details which are applicable to the work at hand. The shapes of apparently minor machine details are determined by principles discovered in actual manufacture and operation. If a man does not know the approved forms of the details of the machine he is designing, he probably knows only a few of the principles involved. Certain forms come to be looked upon as good practice in a certain line, and if these are adhered to the machine is easier to sell than one which contains something strikingly original, but the successful operation of which will possibly be doubted.

Even if one thinks his design for a new machine to be largely original, he seldom compounds it out of purely single elements, but is usually unconsciously making many adaptations from combinations he has seen, however limited his knowledge may be. He gains no more credit for being an unintentional imitator than for being a conscious imitator. He may have given good training to his inventive faculties by working out a few entirely new mechanisms, but the result of his work will probably not be so successful as if he had incorporated as many previously proved combinations as were possible mechanically and legally. It is certainly unwise for the man just out of school to draw mainly upon what he has learned there and upon his imagination for his designs. From the basic mechanisms given in his text-books he can, perhaps, reason correctly concerning the operation of modifications, but he can make a great gain in efficiency if he stores his mind with all the designs he can observe in practice and technical literature.

There are comparatively few positions that offer to the designer the opportunity to use or develop his inventive faculties in sufficient degree to attain maximum advancement through knowledge gained during his work alone. About all most positions offer is an opportunity for one to use and cultivate an ingenuity for adaptation from known designs in his own or other fields. This requires observation and absorption to qualify one as a designer more than it does the ability to originate. A knowledge of the details of construction of a wide variety of machines will enable a person to adapt parts of them to other purposes, to modify them to suit special conditions, or to duplicate them if required, even if the designer has not come into contact with them. He can do this in much less time than when he knows only the fundamental principles of mechanics, in relation to the machine he is called upon to design, and is obliged to rely upon his inventive faculties for working out the details. Employers advertise for men experienced in a certain line far more often than they advertise for men capable of originating new devices. Before one is asked what can be developed for a certain purpose, he is asked what others have done. The more ideas of actual tested mechanisms a man can bring the better the employer likes it. Even an able designer, acquainted only with the general appearance of a lathe and unfamiliar with the details of construction, who should attempt to design one without first making a study of the machine, would undoubtedly produce the same comparatively inferior tool as the early designers.

The writer thought that the ability to originate was the most necessary qualification for success in the engineering world; but now believes that, in most positions, a qualification which is of more value to one's employer, and consequently more lucrative to oneself, is having such an intimate knowledge of machine construction in many fields that it is rarely necessary to originate. If a designer can modify and adapt to his needs some combination of elements previously used and known to have worked successfully, he has made a commercial gain, even if he has not made as great a scientific gain as if he had spent more time and money in evolving a new combination of elements. Also, if a designer is not familiar with the ground already covered in his field, he will probably retrace the steps of others and believe the combination he is developing is new. It should be possible, when one is thoroughly acquainted with a certain line of industry, to avoid the tendency to duplicate designs which he knows, if it be necessary. But he is more likely to avoid duplication than the man who knows nothing of the field, however prolific the latter may be of ideas which he thinks have been unused. Where there is one position in which the ability to originate new forms or mechanical combinations is the prime requisite, there are possibly one hundred draftsmen's or engineers' positions demanding a knowledge of the employer's product, acquaintance with the design of some machine which he wishes to build, and experience in production, erecting or operation. Therefore much of a designer's training should consist in becoming acquainted with machinery used in all fields, in order to modify and adapt known combinations to the work in hand.

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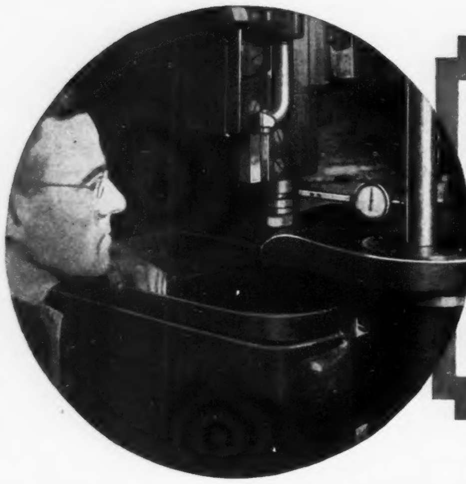


Profile and Indicating Gages[1]-I

by Douglas T. Hamilton[2]

MANY different types of gages have been devised for testing surfaces, measuring shoulder distances, and determining the amount of eccentricity or the truth of cylindrical parts. The ordinary plug or snap gages, while extensively used in interchangeable manufacture, do not indicate the amount of error that exists in the part; they simply determine whether the parts are small or large. The solid profile gage has a similar disadvantage in that it does not show how much the profile of the part is out; on the other hand, properly designed indicating gages can be so applied that any error in the part can be determined with a reasonable degree of accuracy. Gages built on this principle are now being used with satisfactory results in the manufacture of munitions, automobiles, balls and ball bearings, typewriters, adding machines, and many other products which are made by the interchangeable system of manufacture. In the following, different types of gages working on the indicating principle will be illustrated and described.

Templet and Profile Gages

Templet and profile gages which are generally made from sheet steel are used for measuring shoulder distances, profiles of irregular shape, and angles on parts. These gages are usually comparatively cheap to manufacture, and in most cases are sufficiently accurate for the work they are intended to inspect. Take, for instance, the gaging of the over-all length of a shaft as shown at *A* and *B* in Fig. 1. For work of this kind a templet gage can be satisfactorily employed. It should be made as shown at *B*, however, rather than as shown at *A*. The reason for this is that there is less liability of the operator's springing the gage by forcing the work into it. In the type shown at *B*, work which will enter the "Go" end of the templet cannot be forced as easily into the "Not Go" size as in the type shown at *A*. On the other hand, the type shown at *A*, when used with care, has the advantage that there is less liability of the operator's fitting the work to the "Not Go" end, instead of to the "Go" end.

Another case where a combination gage can be used with satisfactory results is shown at *C*. In this case the templet controls the shape of the head as well as its thickness. Although more than one point is being tested by this gage, the work is not usually required to be very accurate, and a templet gage of this nature is satisfactory. Reference to this illustration will show that the work on the "Go" end should bear all over on the gage, whereas on the "Not Go" end it will not go completely down into the slot. Where the thickness of the head from a shoulder is the only point that is necessary to hold accurate, a gage of the swinging arm type is much more satisfactory than the templet form. This matter, however, will be dealt with more fully later.

A simple templet for testing work of angular shape is shown at *D* in Fig. 1. In this case the templet is used to test the diameter of the screw and the thickness and angle of the head. For accurate work, too many points are being tested, but for the average run of flat-head screws a templet gage of this type gives satisfactory results. When greater accuracy is required on work of this shape, a progressive gage covering each individual point would be the most satisfactory one to employ.

Another application of the templet system of gaging in the production of shoulder shafts is shown at *A*, *B* and *C* in Fig. 3. At *A* is shown a templet which is used for controlling the shoulders of one end of the shaft—for the first operation; at *B* is shown the gage for controlling the length of the shoulders on the opposite end of the shaft—for the second operation; whereas at *C* is shown the gage used by the inspector for covering the entire length of the shaft. It is much more satisfactory to supply the workman with a gage of the type shown at *B* for the second operation than it is to supply him with the type shown at *C*. The latter should only be used by the inspector for the reason that as long as the work goes in this gage it is satisfactory. If it does not go in the gage, it is unsatisfactory. This gage is therefore given as wide a permissible tolerance as possible. For the second operation, as shown at *B*, the shoulder *a* would be controlled by the end *b* of the gage. When the length of certain shoulders is required to be accurate, this system of inspection is not recommended, and a limit gage as described later should be employed.

A form of templet gage which is used extensively in the manufacture of engine lathes and other similar machine tools is shown at *D*. This gage is used for testing the angle on the ways of the lathe on which the carriage operates, and at the same time for determining if the center distance is correct. Extremely accurate results are obtained by means of this templet gage in the hands of an experienced operator. Either a feeler or thin piece of tissue paper is used to test

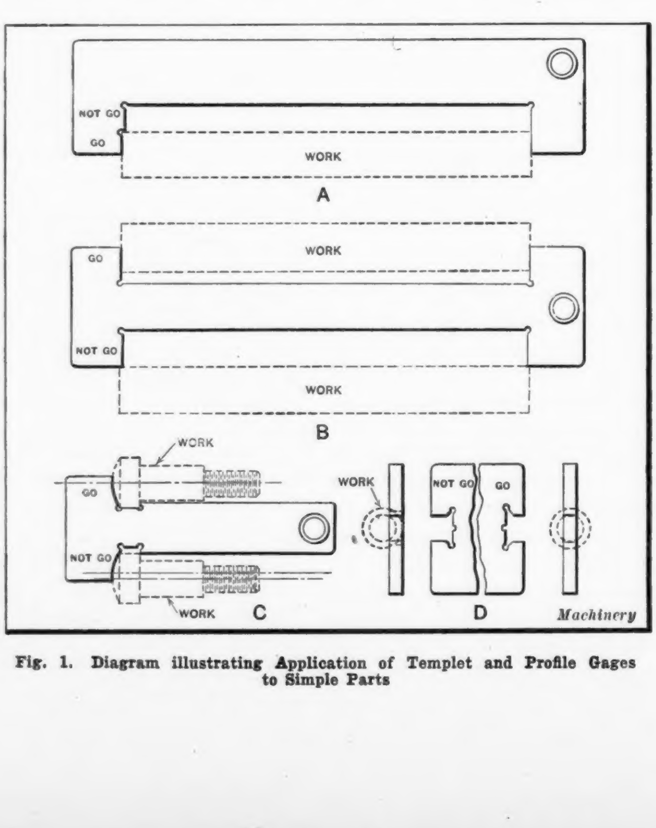


Fig. 1. Diagram illustrating Application of Templet and Profile Gages to Simple Parts

[1] For information on gages and gaging previously published in MACHINERY, see "Gaging and Inspection Methods" in the October number, and articles there referred to.
[2] Associate Editor of MACHINERY.

both the angle and the center distance of the ways. When templet gages of this shape are accurately made and carefully applied, satisfactory results are obtained.

Another application of the templet system for testing the arc of a circle is shown at E and F. In this case the part being tested is a ring for a ball thrust bearing. At E the curve on the lower surface is being tested with a templet, whereas at F two knife-edge shaped disks are used to test the center distance of the raceway. Inaccuracy of the work is indicated by light showing between the gage and work, but the gage does not determine how much the work varies from the size or shape required. For this purpose, an indicating gage should be used in preference to the templet form.

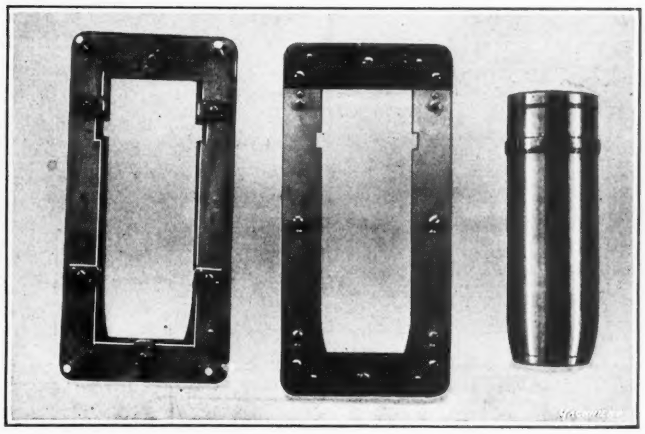


Fig. 2. A Built-up Type of Profile Gage for Russian Shrapnel Shells

An application of the templet form of gage to curve and length measurements is shown at G. In this case the piece being tested is the ogive or nose end of a shell. Two points are tested: one is the shape of the nose, and the other the location of the lower end of the bourrelet. It might be mentioned in passing that the bourrelet is the cylindrical portion on the head end of the shell which rests in the gun and is formed by the termination of the ogive and the beginning of the reduction on the body, this being allowed to facilitate manufacture and also prevent the shell from bearing for its entire length in the bore of the gun. In this case it will also be noticed that the templet is so made that it can be used in connection with the limit system of manufacture, having two lines on it, one indicating the minimum and the other the maximum position of the bourrelet. The position desired is, of course, between these two points.

Built-up Templet Gage

A built-up templet or profile gage which was made to supersede one made from 5/32-inch sheet steel is shown in Fig. 2. This is used for the final inspection on a 3-inch Russian shrapnel shell. Work which passes through it is satisfactory, while work which will not pass through it is rejected. The gage is provided with legs which support the outline plates at a distance from the surface plate equal to the radius of the shell. In construction, it consists of a base made from mild stock 5/16 inch thick with a clearance hole of approximately rectangular shape. On one side of this baseplate are screwed and doweled four strips of hardened tool steel which form the gage proper. It is also provided with six bumper pieces attached to the lower side of the gage body. These bumpers are tapered back so as to form a bell-mouth and locate the shell approximately as it is about to enter the gage. When the profile of the gage wears, any one of the four strips is moved inward, correctly placed, and then the dowel holes are re-reamed for a slightly larger dowel-pin.

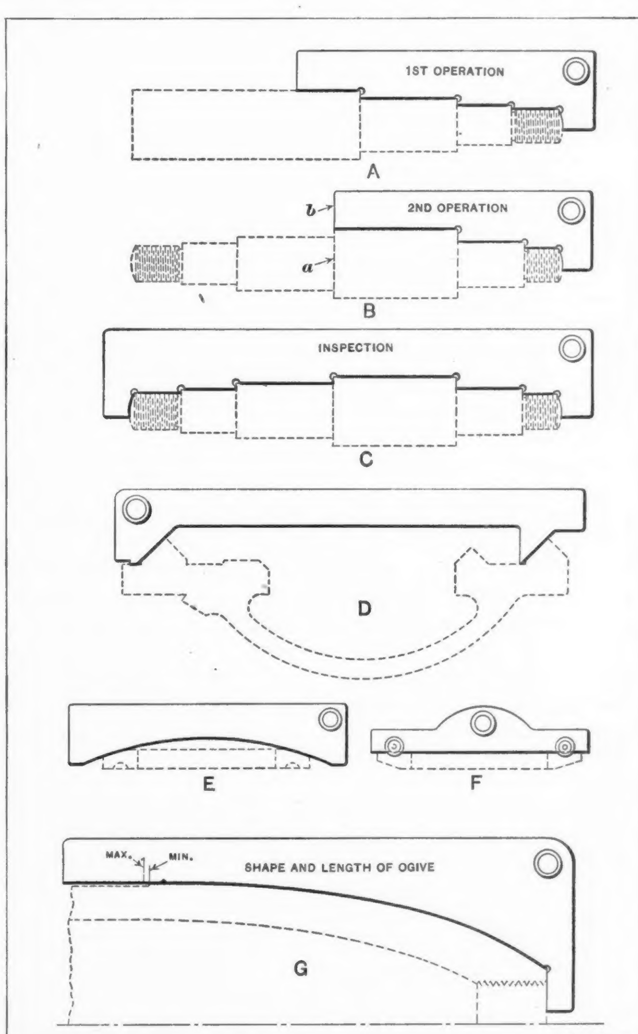


Fig. 3. Various Forms of Templet and Profile Gages

Limit System Applied to the Gaging of Shoulder Distances

Fig. 4 shows a gaging device for inspecting shoulder shafts, that works on the limit principle. This gage consists principally of a base A carrying a V-block B in which the work is clamped by means of a strap C and the swinging bolt D. The relative locations of the two shoulders is determined by two levers E and F, respectively, which carry limit buttons of the form shown at G. These levers are fulcrumed on one side of the gage on a pin H, and fit in slots in the hardened, ground and lapped block I. In using this gage, the work is put into the V-block, and the operator holds it with one hand while he moves down lever F with the other hand until the shoulder J on the work contacts with the "Go" limit on the plug held in lever F. The swinging strap C is then clamped by means of bolt D, holding the work rigidly in position. The operator then brings down lever E and tests the location of the second shoulder in relation to the first. In this way shoulder shafts can be held within very close limits when necessary. If the limits were very close, it would be possible for the operator to spring the "Not Go" surface on the plugs past the work, but as in practically all gaging devices the sense of touch is necessary, there is no reason why an operator should apply greater power when he has the leverage to do so than is necessary to bring the measuring surfaces on the gage in contact with the work.

Progressive or Combination Gages

Gages which are used for inspecting a number of points on one particular piece are generally termed combination or progressive gages. One type of gage which illustrates this principle is shown in Fig. 5. In this case the gage is being used for testing the body, over-all length, head, slot and thread of a fillister screw. The only part on which a limit of tolerance is provided is the thread. This is tested in a "Go" and "Not Go" threaded bushing inserted in the templet. Gages of this kind have one marked disadvantage in that as soon as any one position or point on the gage becomes worn, with the exception of the threaded bushings, the entire gage has to be destroyed. For work such as screws which do not require to be extremely accurate, this gage gives fairly good results and is quite extensively employed. When the work demands greater accuracy, however, separate gages should be provided for testing each particular point. This necessitates a more costly outlay, but when very accurate work is essential, the cost of upkeep is less.

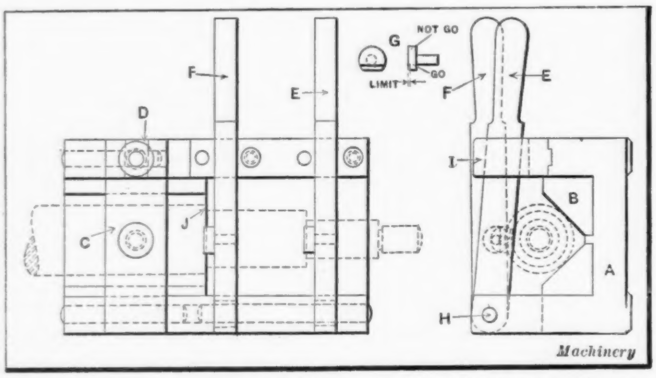


Fig. 4. Diagram illustrating Application of Limit System to gaging of Shoulder Shafts

Progressive Gaging of Cartridge Chamber in Rifle Barrel

Another example which could come under the class of progressive gaging is shown in Fig. 7. This illustrates the tools and gages used in machining and inspecting the cartridge chamber of a rifle barrel. Those experienced in this work know that it is not an easy problem to produce a perfectly chambered rifle, and it requires both a high degree of workmanship and a complete and practical gaging system for its accomplishment. The chart shown in Fig. 7 illustrates the counterbore, roughing and finishing reamers, and also the roughing and finishing gages used for machining and gaging the chamber in a 0.303 Ross military rifle. At first glance it would appear that there is an excess of gages used; however, this is not the case, as the following explanation will show.

The manner in which these tools and gages are used is as follows: The chamber is first roughed out with a counterbore *M* and then gaged at the mouth and in the bore with the gage *A*, to see that the counterbored hole is of the exact diameter and is concentric with the bore in the barrel. (It is necessary that this point be carefully determined, because any eccentricity would be difficult to correct in the following operations.) The chamber is now reamed with a roughing reamer *N* and gaged with the gage *B*. The reamer shown at *O* is then used for finish-reaming the taper and neck and also for roughing the cone diameter. It would be impossible to make one gage so that it would act as a detector for all the various diameters finished by this reamer, and this inspection operation requires the use of gages *C*, *D*, *E* and *F*, the limit lines on which should come flush with the end of the barrel when the reamer is of the correct size and is inserted to the proper depth.

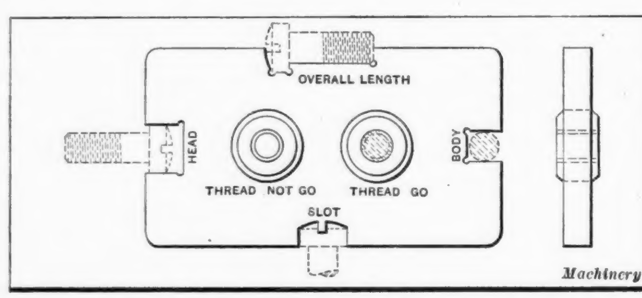


Fig. 5. Progressive Type of Templet Gage for inspecting Fillister-head Screws

This finishes the rough-reaming and respective gaging operations, after which every part of the chamber is again finished with finishing reamers and gaged. The operations accomplished by the reamers *P* to *T*, inclusive, are inspected with the gages *G* to *K*, inclusive, which are made so that a slight change in diameter can be noted by shaking the gage. The reamers *U* and *V* and the gage *L* are used for machining and gaging the lead to the rifling grooves. The lead may be briefly defined as the conical funnel which leads from the chamber to the bore. If the chamber ended abruptly at the beginning of the rifling grooves in the bore of the barrel, the sharp ends of the lands would cut strips out of the nickel jacket case of the bullet and the latter would fly to pieces when it left the muzzle of the rifle. The lead, therefore, must be concentric with the chamber and bore, or else the bullet will be likely to wobble or tumble after it leaves the muzzle. Hence all points along the chamber must be concentric with the bore, and the progressive system of gaging is necessary to obtain the desired accuracy.

Progressive Gaging of Screw Machine Products

The two previous examples of progressive or combination gages illustrate the types in which it is necessary to apply the gage to the work. When a considerable number of points on the work require gaging, and especially when the work is quite large, it is necessary to have a large gage of the type shown in Fig. 5, which is rather bulky to handle. On the other hand, in gaging work like the cartridge chamber in a rifle barrel, shown in Fig. 7, where a large number of gages are required, it necessitates lifting up and putting down each gage once for each barrel inspected. A method of progressive gaging which can be applied with particularly satisfactory results to screw machine products, such as the bicycle wheel hub shown in Fig. 6, is illustrated diagrammatically in Fig. 8. Here the gage consists of a large cast-iron plate, the top surface of which is carefully machined and preferably finished by grinding. It will be seen that various types of gaging points, plugs, swinging members, etc., are attached to the top surface of this plate.

Diameters *A*, *B*, *C*, *D*, *E*, and heights *F*, *G*, *H*, *I* and *J*, Fig. 6, can be gaged in a satisfactory manner as shown in Fig. 8. For instance, for gaging the diameters *A* and *B*, four sets (two each) of carefully hardened and ground blocks are fastened to the plate, the first two blocks in each set being known as the "Go" sizes, through which satisfactory work will pass, and the second set as the "Not Go" sizes, through which work of the required size will not pass. When it comes to the gaging of the hole diameters *C*, *D* and *E*, ordinary plugs are fastened to the surface plate, one being made to go in the hole and the other not to go in. For gaging the depth of the counterbore *F*, the work is placed on a spring plug, as indicated in the section of the end view of the fixture. Here the lower face of the work rests on a swinging arm, and in doing so forces down the spring-operated plunger. When the work is correct, this slips over the "Go" block, but will not go over the "Not Go" block. For gaging the height of the shoulder *G*, the work is let down into the swinging arm instead of on a plug, and the work itself, instead of a hardened plug, passes over the "Go" block when correct, and not over the "Not Go" block when too long. For the gaging of the height *H*, a similar scheme to that used for gaging the height *F* is adopted. For gaging the height *I* and also the taper, the plug is made with a tapered shoulder and the work rests on this taper and is guided near the bottom only by a shoulder on the stud. In this way, the height and diameter of the taper are controlled. For the over-all length, the work is simply passed under a height block; it goes under the "Go" block, but will not enter the "Not Go" block.

The facility with which work can be handled in this manner is remarkable. For instance, an experienced operator could gage all the ten points noted on this particular part in from eight to ten seconds, and when the tolerances on the work are from 0.003 to 0.005 inch, this type of gaging is sufficiently accurate. It is especially advantageous for the inspection of work which after being turned out on the screw machine or turret lathe is heat-treated and then must be finished by grinding. The grinding tolerances, of course, can be provided for on this rough inspection gage. Where a greater refinement is

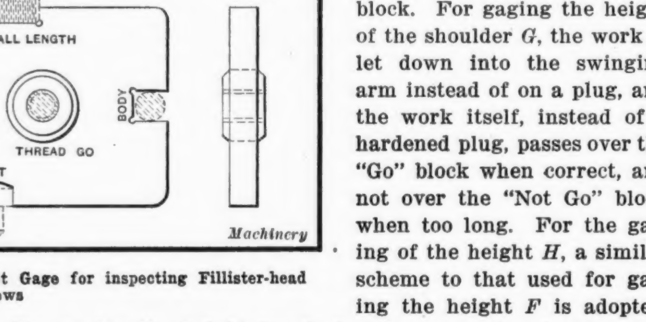


Fig. 6. Bicycle Wheel Hub which can be successfully inspected by Method shown in Fig. 8

necessary on the work, accurate gages can be fastened at frequent intervals to the top surface of the plate and the gaging of the parts accomplished. For instance, it would be a simple problem to attach any type of indicating gage to a plate in this manner and thus bring all the gages for any certain piece together, so as to eliminate the necessity of lifting the gage to the work or moving from one place to the other along a bench. This principle, of course, works out very successfully when the work is comparatively light, clean and free from burrs.

In designing a gaging fixture of this type, it is desirable to keep the work on the surface plate as much as possible. This feature has been adopted because it is simpler to slide the piece along the plate than it is to keep lifting it up from point to point. Of course there are cases where this is impossible, but the aim in view should be to eliminate as far as possible any feature which would tend to tire the inspector. Another advantage of this type of gage is that girls can be satisfactorily employed for the work.

Principles of Indicating Gages

Indicating gages may be divided into three distinct classes; namely, those employing the sense of touch, those depending on sight, and those on hearing. These three different classes, of course, are subject to considerable subdivision, but the main principles involved remain the same. Gages which employ the sense of touch are known as flush pin or feeler gages; those employing the sense of sight are multiplying lever or dial indicating and micrometer gages; whereas those depending on the sense of hearing can be grouped into those employing some means of indicating by sound when the part is of the required size, tension, etc. A common type of gage employing this principle is an electric gage, in which a bell is rung if the piece is O. K.

Indicating Gages Employing Sense of Touch

The most common form of indicating gage employing the sense of touch is the flush pin type of gage shown in Fig. 9. Reference to this illustration will show that the gage consists of a base *A* carrying a bracket *B* and a measuring spindle or flush pin *C*. The forward end of bracket *B* is machined to circular shape and is provided on its top surface with a step equal in height to the permissible tolerance on the work—in this case 0.005 inch. The lower end of spindle *C* is made sufficiently large to seat on the counterbored seat in the work. The distance from the lower face of this enlarged portion to the reduced shoulder on the spindle is such that when work within the required limits is being tested, the counterbored seat in the work will lift the spindle up sufficiently to bring the shoulder on spindle *C* either flush with the upper or lower shoulder on the boss on bracket *B* or midway between these points. Of course, the desired condition is to have the shoulder on the flush pin midway between the plus and minus limits. While 0.005 inch can be seen with the naked eye, it can be detected more rapidly with the finger, so that this type of gage is known as the flush pin or touch type of gage. The sense of touch is much more accurate than most people appreciate, and as a matter of fact, it is possible to detect differences as small as 0.0003 inch.

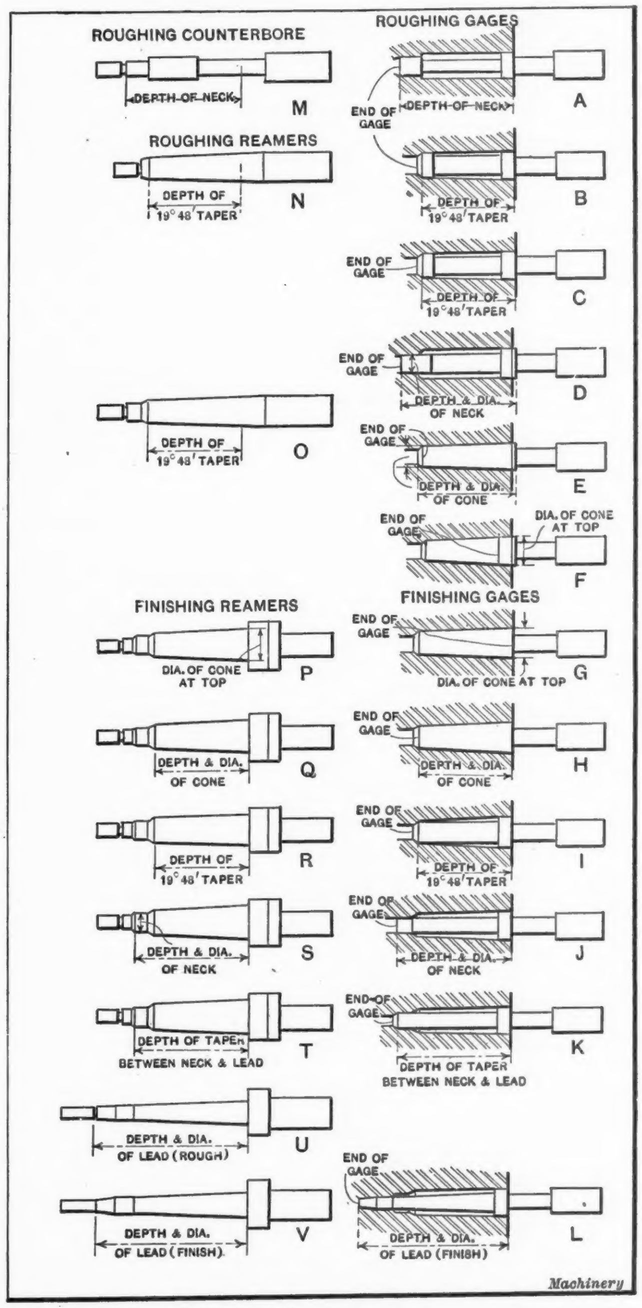


Fig. 7. Tools and Gages used in machining Cartridge Chamber in Military Rifle Barrel, illustrating Another Method of Progressive Gaging

Another type of gage which depends for its accuracy on the sense of touch or feel is shown in Fig. 10. This gage is used for testing the position of the milled groove on the under side of a bolt sleeve for a military rifle. The sleeve proper is held in a fixture on hardened and ground plugs *A*, *B* and *C*. Plug *A* is provided with a knurled head and is made a good fit in the hardened and ground sleeve *E*. Plug *B* is made with a tapered shank and is held in a hardened and ground taper sleeve by a stud and nut as shown. The sleeve *F* is provided with a shoulder which abuts against the cast-iron boss on the base *D*. Plug *C* is tapered, fitting a hole in the handle of the bolt sleeve, and is driven into reamed holes in the boss on the casting. The inspection is done by means of what is known as a rocker block, which is made from steel, hardened, ground and lapped. This block works on the hardened and ground block *G* fastened by screws and dowels to the casting *D*, which acts as a measuring surface for the rocker gage. The rocker gage or block *H* has three bosses on the sides, two of the bosses on each side acting as supports, while the other boss is made lower than the supporting bosses an amount equal to the tolerance allowed on the work. This gage is also used for testing the height of the shoulder *I* on the bolt sleeve, the rocker *H* being located on the hardened and ground block *J* in a similar manner to that previously described. In applying this rocker, it is laid on the hardened and ground surfaces on the fixture and then moved forward to see if it will pass over the work. The "Go" end passes over the work and the "Not Go" does not, if the work is satisfactory.

A flush pin gage which is used for determining the depth of a slot in a rifle part is shown in Fig. 11. In this case the slot *A* in the part is inspected by two flush pins *B* and *C* which are held in a swinging member *D* in the bracket *E*. Swinging member *D* carries a hardened and ground locating plug *F* which, when in position for gaging, comes in contact with a hardened and ground plug *G* in the base of the gage. These two pins insure that the swinging member is always brought to the same position. Then by feeling the height of the flush pins in the swinging member, the depth of the slot is tested; the piece being gaged is held on the base of the gage on dowel-pins, and is ejected after being tested by means of handle *H* through an eccentric movement.

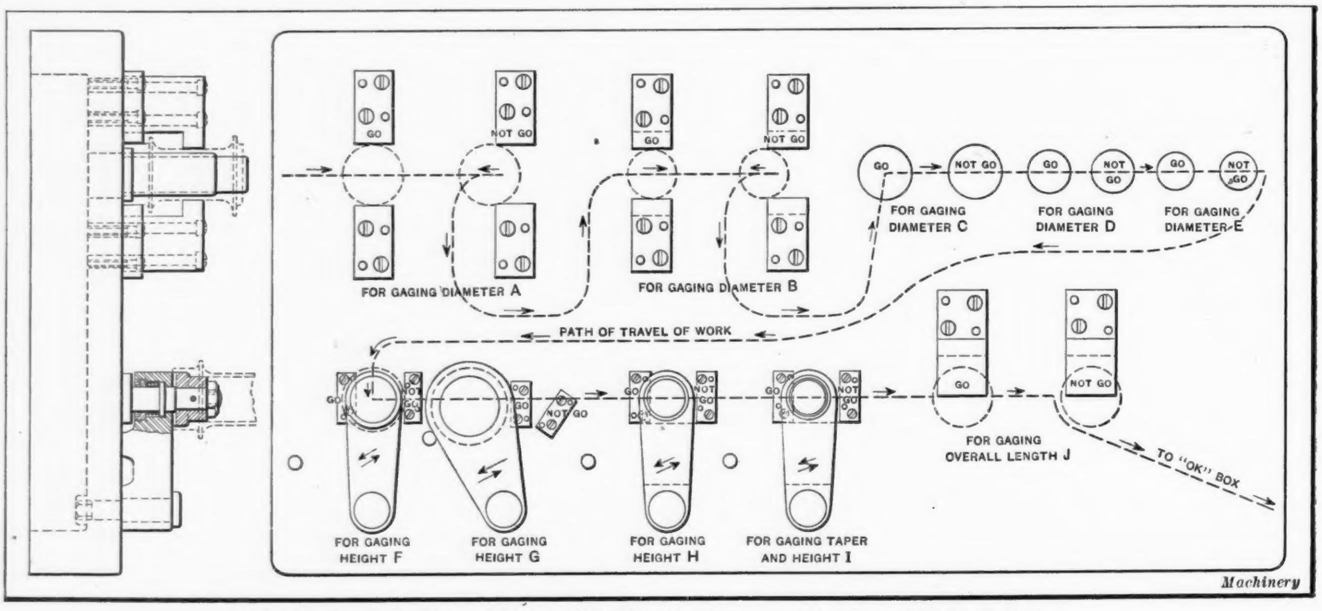


Fig. 8. Progressive Type of Gage particularly adapted for inspecting Screw Machine Products

Indicating Gages Employing Sense of Sight

Indicating gages employing the sense of sight can be roughly divided into five general classes, *viz.*, those of the multiplying lever type; those of the needle and dial indicating type; those employing a micrometer screw; those using the cross-hair microscope in connection with the micrometer screw; and those employing the reflection of light rays.

The average gage constructed on the multiplying lever principle, when used for fine measurements, has several disadvantages, chief among which is the weight of the moving parts. This can be largely compensated for, however, by the correct proportioning and arrangement of the levers so as to balance the weight of the various parts. When set by a master and used simply as a means of comparison, the multiplying lever indicating gage can be satisfactorily employed on a large range of work.

Needle and dial indicating gages are made in several different types, the type employing a train of gears for accomplishing the multiplying movements of the needle being the most common. This form of indicator has several objections which might be summarized as follows:

1. Backlash in the gears due to wear.
2. Fluctuation of the indicating needle.
3. Lack of brake or dash-pot to eliminate fluctuation of the needle.
4. Unequal wear of moving parts—especially gears.

As a rule, a gage of this type is used on one size of work for weeks at a time, with the result that those portions of the gears constantly in mesh wear down much more rapidly than the remaining or unused portions. This unfits the gage for anything but comparative measurements, and it must be corrected and set frequently by means of master blocks.

The fluctuation of the indicating needle is one of the most annoying features of this type of gage. It is due, of course, to the unbalanced action of the parts and, as previously mentioned, to backlash in the gears. For rapid inspection, a gage in which the needle continually fluctuates is of little or no value, and it has been suggested by inspectors that a brake or dash-pot be provided in order to eliminate this objectionable feature. The computing scale is a good example of a measuring instrument employing a dash-pot, and a similar arrangement adapted to an indicating gage of the needle type would greatly increase its usefulness. Unequal wear of the moving parts is also a factor which should receive careful consideration. The number of parts employed in a gage of this type should be reduced to a minimum, so as not only to simplify its construction, but also to decrease the chances for wear and consequent inaccuracy. As will be explained later, other types of needle indicating gages have been devised which do not have the objections previously mentioned.

The micrometer caliper is a type of gage which depends both on sight and touch for its accuracy. The micrometer screw has been applied to many different types of gages, and as will be subsequently described, this type of gage has certain advantages for work which cannot be measured by any other means or which is inaccessible to a regular snap or plug gage.

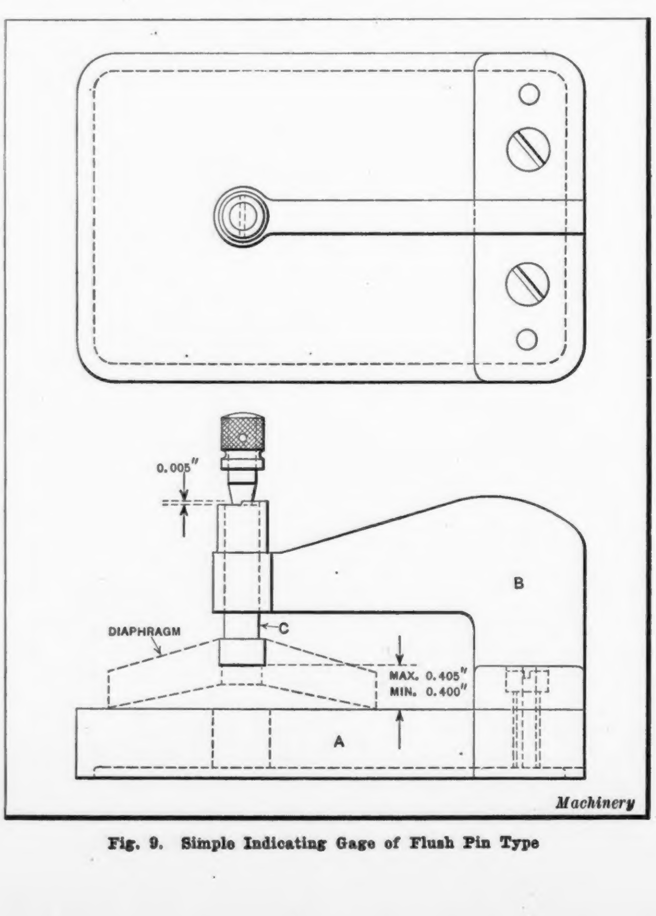


Fig. 9. Simple Indicating Gage of Flush Pin Type

The micrometer screw, of course, furnishes an accurate means of inspecting work, but it is necessary that a gage of this type be frequently checked up to see that the screw is not worn and that the measuring points of the gage are parallel with each other.

The cross-hair microscope in connection with the micrometer screw provides one of the most accurate methods of inspecting small articles, such as type, thread gages, ball races, fly-cutters, etc. The number of industries, however, employing this instrument is not nearly as great as its adaptability would seem to warrant. For many classes of work the accuracy which can be obtained by this method is much greater than that which would ordinarily be required.

For extremely accurate work, gages employing the reflection of light rays have been developed. These, however, are not extensively used

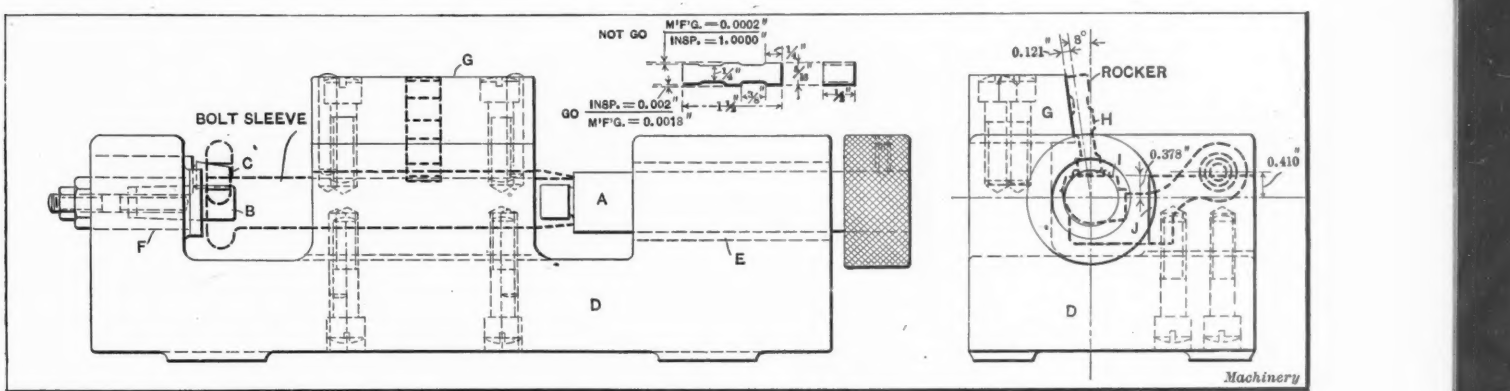


Fig. 10. Example of Feeler Block Type of Gage

and have only been adopted where extreme accuracy is necessary and where a large number of parts must be inspected in a certain time. The light ray presents a rapid means of ascertaining inaccuracies as small as 0.0001 inch, which can be read off from a screen with marvelous rapidity. For such work, a highly developed inspection and gaging system is necessary.

Multiplying Lever Indicating Gages

Multiplying lever indicating gages are made in so many types that it is impossible to cover them all here. An endeavor will be made, however, to deal only with principles of construction and operation. Fig. 12 shows a common form of multiplying lever indicating gage which, in this case, is being used for testing the depth of the powder groove in the ring for a combination time and percussion fuse. The gage, as will be seen, consists of a base *A* provided with a dovetail groove in which the work-holder *B* is free to slide. A stud *C* in the rear end of the base acts as a pivot for the swinging arm *D*, the latter carrying the indicating needle *E* and plunger *F*. The fulcrum point of pointer *E* is so placed in relation to the section which contacts with plunger *F* that a multiplying movement of 40 to 1 is obtained; that is, the lengths of the two arms *X* and *Y* are in this ratio. To insert the work under the measuring plunger, arm *D* is raised, its upper movement being stopped by the fillister-head screw *G*. For this arrangement it will be noted that a single multiplying lever is used.

There are several objections to this gage. In the first place, the necessity of raising arm *D* to insert the work makes it possible for dirt to collect under the seat, and thus cause the gage to read incorrectly. It is also unsuited for very accurate work because of the small multiplying movement of the lever, which gives only 0.025 inch between each graduation on the scale for each 0.001 inch variation in the work.

Multiplying Lever Gage for Internal Work

Another multiplying lever indicating gage, which is used for measuring internal work in this case, and is provided with two multiplying levers, is shown in Fig. 14. Reference to this illustration will show that the gage comprises a sleeve *A*, inside of which is fitted a member *B* milled out to receive the two multiplying levers *C* and *D*. The gage is provided with three contact points, only one of which—point *E*—is movable, the other two being adjustably held in the sleeve *A*. A coil spring, as shown, keeps the forward end of lever *C* in contact with the lower end of contact point *E* and another spring keeps the forward end of lever *D* in contact with the rear end of lever *C*. In this way the point constantly follows any irregularities in the work which are indicated on the dial *F*. On the exterior of sleeve *A* is a bushing *G*, which can be moved back and forth. The function of this bushing is to keep the axis of the gage parallel with the center of the work as nearly as possible, the sleeve, of course, being pushed back and forth, depending on the distance from the face of the work that the measurement is being taken.

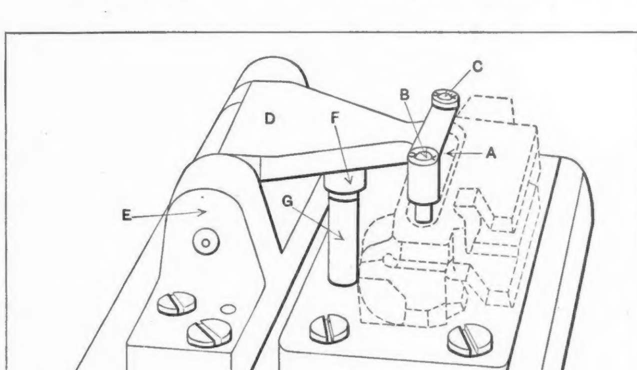


Fig. 11. Flush Pin Type of Gage employing a Swinging Arm

This gage has several objections: One is the small multiplying movement which can be obtained; another is the fact that two springs working against each other are employed; and a third is the unbalanced weight of the moving parts. In a gage built on the multiplying lever principle, the multiplication should not be less than 60 to 1, 100 to 1 being preferable. This provides for a movement of the indicating needle of approximately 1/16 inch for each 0.001 inch variation in the work. In the case of a multiplication of 100 to 1, the space between each graduation, representing variations in the work of 0.001 inch, would be 0.100 inch, which is still better.

Simple Type of Multiplying Lever Indicating Gage

A multiplying lever indicating gage which can be used for accurate work is shown by the diagram Fig. 13. This gage comprises two levers, which provide for a multiplying movement of 240 to 1; that is, variation in the work of 0.001 inch would cause a movement of 0.240 inch of the upper end of needle *A*. Segment *B* is, therefore, provided with graduations 0.024 inch apart, which is equal to a variation of 0.0001 inch in the work. The connection between levers *A* and *C* is by means of a rack tooth, and lever *A* is counterweighted, as shown at *D*, making a spring unnecessary. One objectionable feature of this gage is the relation of the lower surface of the upper or movable anvil to the center line of lever *C*. For accurate readings, the measuring point should be in line with the axis *X—Y*. As this gage, however, is only used for comparative measurements, and set by a master, this objection does not seriously affect its other advantages, which are simplicity of construction and magnification.

The Hirth Minimeter

A multiplying lever indicating gage which comprises some very valuable features from the standpoint of both accuracy and construction is shown in Figs. 15 and 16. This gage is now being used extensively by various concerns in this country, and can be adapted to almost any class of work by simply arranging suitable stands for holding the measuring gage proper. It is handled in this country by the Norma Co. of America, New York City. Fig. 16 shows a sectional view through this gage, illus-

trating its working mechanism. The principle upon which this gage works is the introduction of a long lever arm *A*, which also serves as an indicating needle, and a short arm, the length of which is determined by the distance between the two knife-edges *B* and *C*. The bearing points of these knife-edges may be varied in order to provide adjustment for the apparatus.

One of the advantages of this device is that it eliminates the necessity for lubrication and overcomes the disadvantage of play on dead centers. As indicated in Fig. 16, a light spring *D* holds the lever against the knife-edge and returns

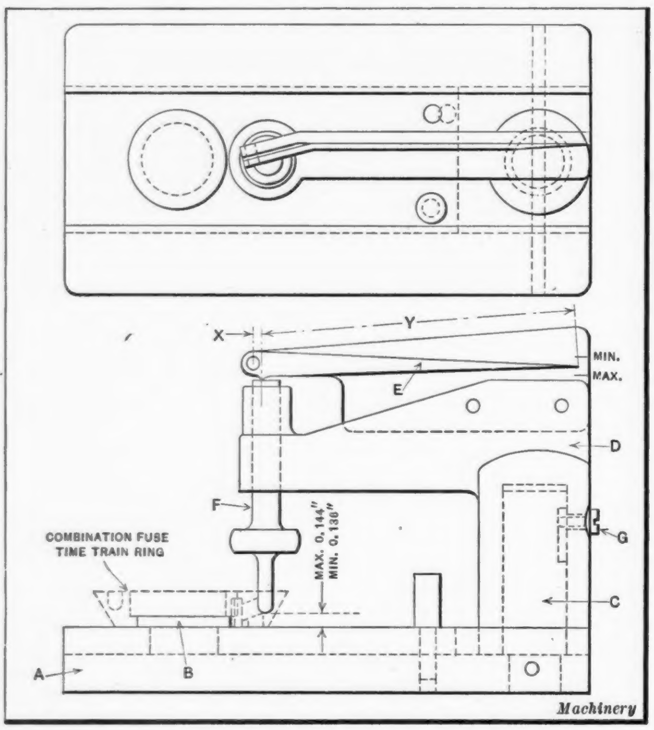


Fig. 12. Common Form of Multiplying Lever Indicating Gage

it to its normal position after measuring. A finger or pin *E*, bearing against the lower knife-edge, gives contact with the work to be measured. Movement of this pin causes the pointer *A* to swing over the scale *F* by displacing one knife-edge in relation to the other. The arc is graduated in different minimeters to give readings to 0.001 or 0.0001 inch. The entire mechanism is enclosed in a tube and the upper part is provided with an opening which permits the graduating scale to be seen and the indications of the pointer to be read off. The measuring instrument proper can be mounted in different holders, as will be described later.

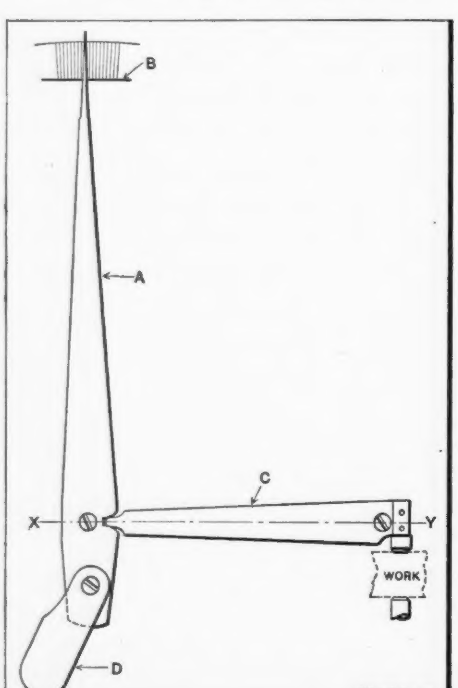


Fig. 13. Diagram illustrating Principle of Multiplying Lever Gage employing Two Arms connected by a Rack Tooth

Principles of Dial Indicating Gages

The chief difference between a dial indicating gage and a multiplying lever indicating gage is the substitution of a graduated dial for a graduated segment, and the provision for making the needle travel one or more times around the dial, instead of just covering the segment of a circle. The dial is usually graduated so as to give readings to 0.001 or 0.0001 inch. In the dial indicating type, as mentioned, some means must be provided for giving one or more rotations to the indicating needle, and for this purpose gears are generally employed. In the multiplying lever indicating type, however, no gears are necessary, as the pointer moves over an arc of a circle only and does not make a complete revolution. For the average run of work, especially in the inspection department, the multiplying lever indicating gage, when correctly designed, is much superior to the dial type. For instance, the type shown in Figs. 15 and 16, which is known as the Hirth minimeter, has been found to be one of the most accurate indicating instruments on the market. In the following, a description will be given of some of the principal features used in gages of the indicating needle and dial principle.

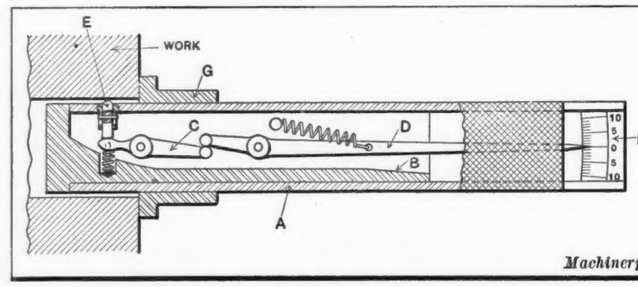


Fig. 14. Multiplying Lever Indicating Gage for Internal Work

The Ames Dial Indicator

In Fig. 17 is shown an Ames dial indicator attached to a simple holder and used for measuring the depth of the powder groove in a ring for a combination time and percussion fuse. The holder consists simply of a cast-iron block machined on the bottom and top surfaces and carrying a hardened and ground plug, which supports the fuse ring being measured. The bracket forming an integral part with this block is machined to receive the spindle of an Ames dial indicator. As has been previously mentioned, a dial indicator should not be depended upon when used on one job for any length of time; it is always advisable to provide a setting block, as shown in the illustration at *A* to check up the instrument periodically. A spring keeps the measuring pointer in contact with the work and it is lifted by means of lever *B*.

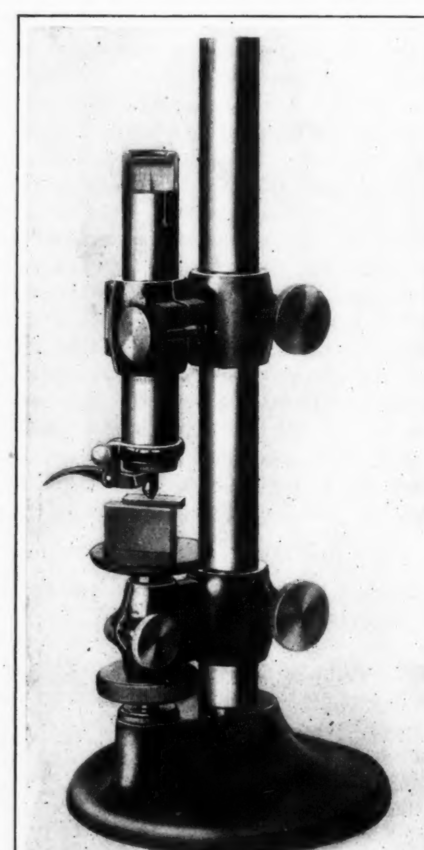


Fig. 15. Hirth Minimeter mounted in Stand Suitable for Average Run of Work

Dial Indicators Employing a Train of Gears

The internal mechanism of a dial indicator which is operated by a train of gears is illustrated in Fig. 18; it consists of a spindle *A* which works in hardened and lapped bushings

inserted in the case containing the measuring mechanism. The measuring spindle A is moved up and down by means of a handle B, to which it is connected by link C and collar D. When spindle A is raised, the rack teeth cut in it mesh with a pinion E, which transmits motion to the gear F, pinion G and needle H. Gear I is interposed to reduce the backlash. The dial is divided into one hundred equal spaces, and each graduation corresponds to a movement of the spindle of 0.001 inch. The table J is adjustable, and a plate K for holding the work to be measured is attached to it by screws. The stud on which table J is held is screwed into a babbitt bushing L, the latter being clamped on the stud by the screw M, the babbitt being poured in after the stud is put in place.

Another type of dial indicator which has a greater multiplying movement than that shown in Fig. 18 is illustrated in Fig. 19. This gage is used for measuring such work as balance staffs, pinions, etc., for watches. It is provided with a dial having two hundred graduations laid off on its face. The work to be measured is placed between the jaws A and B, which are separated by forcing in rod C to which jaw B is

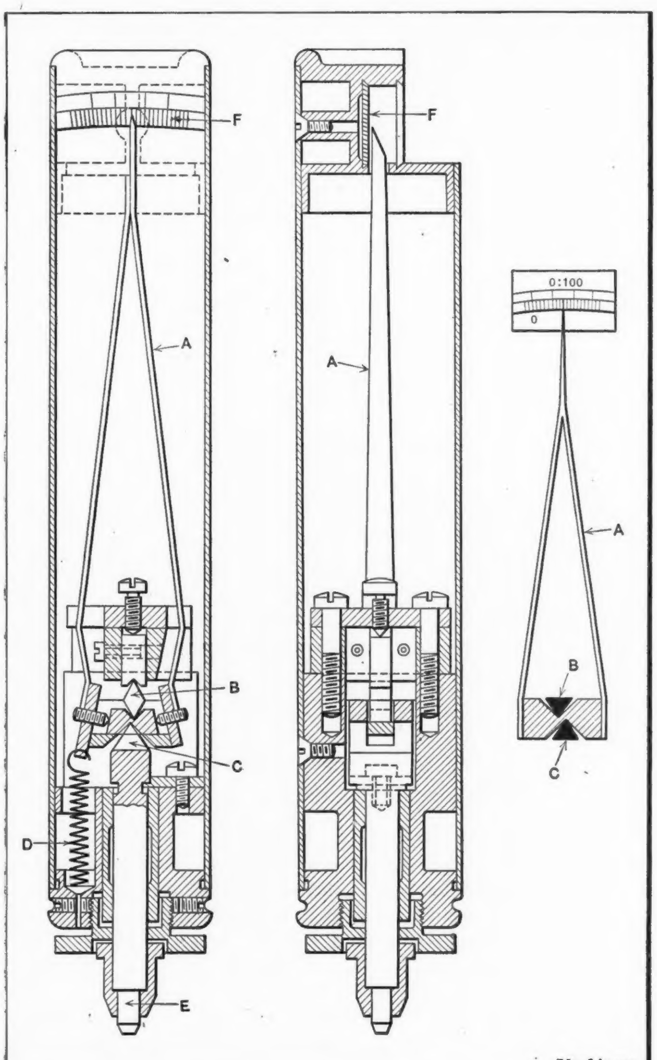


Fig. 16. Diagram illustrating Principle of Hirth Minimeter shown in Fig. 15

attached. Held on this rod by a screw is a rack D, which meshes with a pinion E having forty teeth. Pinion E is connected to segment gear F (the whole number of teeth in which should be 225), which meshes with pinion G attached to needle J. Jaw B, which is held by a screw to rod C, has a slot cut in its rear end which fits a flattened stud H, thus preventing the jaw from tilting. One complete revolution of needle J around the dial gives a corresponding movement between the jaws A and B of 0.080 inch, so that the space between each graduation of the dial represents a movement of the jaw of 0.0004 inch. The working mechanism of the gage is enclosed in a case and supported on a stand I, as shown.

A still more sensitive dial indicating gage or comparator is

Fig. 17. Ames Dial Indicator used as Depth Gage

shown in Fig. 20. This gage also employs the pinion and gear feature, and is so arranged that one revolution of the needle around the dial represents a movement of the anvil or measuring spindle of 0.010 inch; as the dial is divided into one hundred equal spaces, this means that the space between each graduation is equal, theoretically, to 0.0001-inch movement of the anvil. Actually, of course, the movement of the needle varies somewhat over different parts of the dial. The working parts consist of a lever A, fulcrum screw B, plunger D, fan gear E and pinion G. The gage operates as follows: When brought in contact with the work, plunger D is moved and the flange on this plunger moves the short end of lever A with which it is kept in contact by the action of spring J on the segment gear and the spiral spring on the plunger. In this way a uniform contact is maintained between the long end of lever A and the pin C, and also between the flange of the plunger and the short end of lever A. The movement of lever A causes the required movement of the segment gear, which turns the pinion and the pointer.

Dial Indicator with Worm for Rotating Needle

An indicating gage of the dial type in which a train of gears is dispensed with is shown in Fig. 21. This indicator,

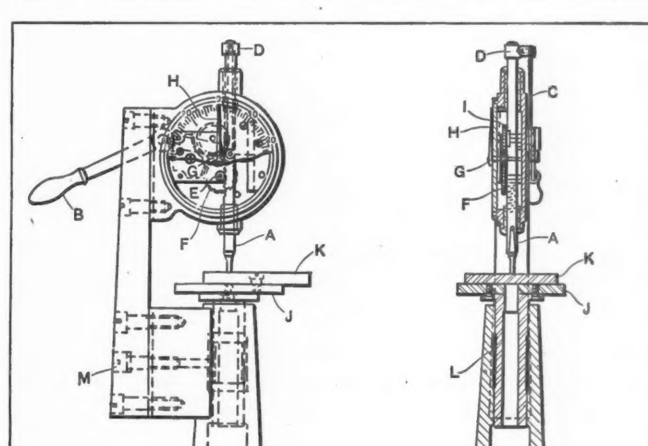


Fig. 18. Sectional View showing Construction of Dial Indicator operated by Gears

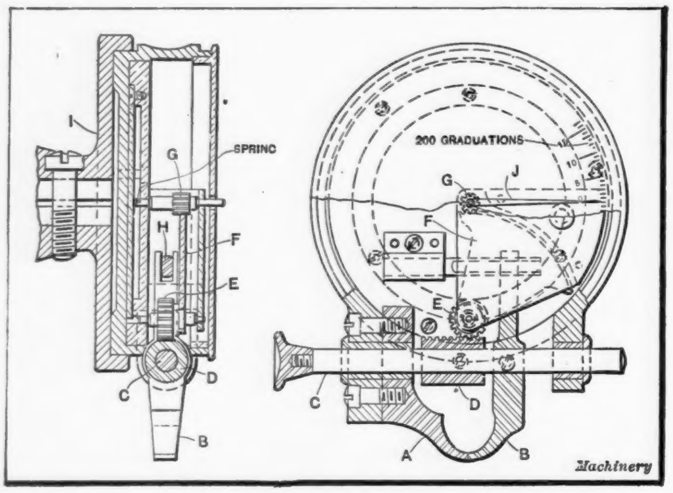


Fig. 19. Dial Gage of the Caliper Type

which is made by H. A. Lowe, Cleveland, Ohio, employs a worm in place of a train of gears for conveying the rotary movement to the indicating needle. As shown in the illustration, this gage consists principally of a body *A* milled out on one side to receive the indicating lever *B*, which is attached, as shown in the sectional view, to the forward end of the body *A*. The forward end of this lever is provided with

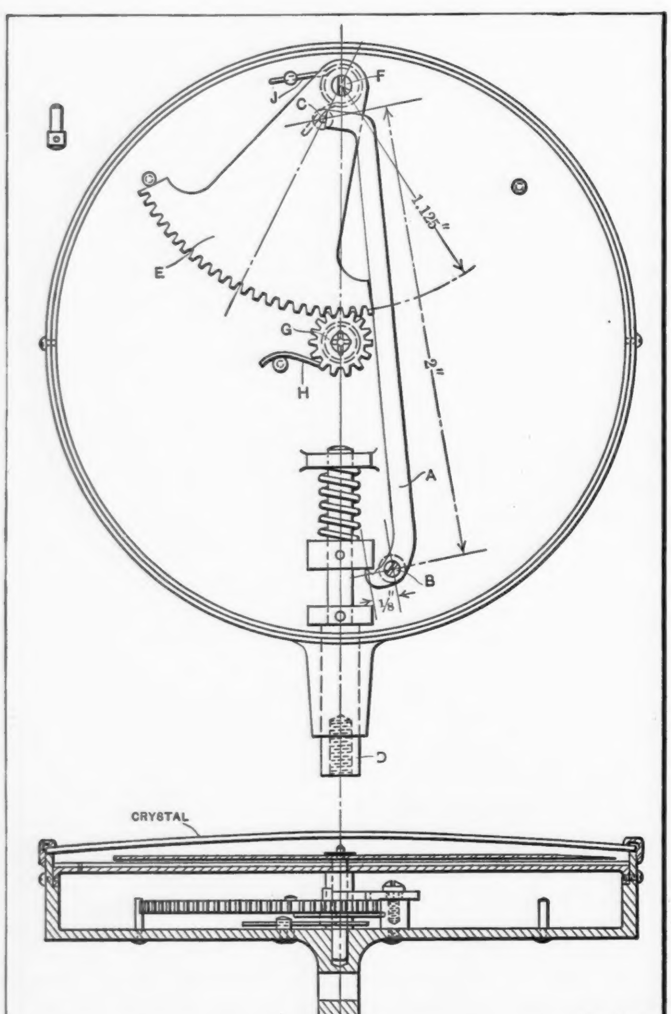


Fig. 20. Dial Test Indicator giving Readings to 0.0001 Inch

a friction joint, which allows the contact point to be moved around through 180 degrees to any required position, thus greatly increasing the usefulness of the instrument. The rear end of lever *B* is provided with a projection fitting in the groove in worm *C*. This worm is held in somewhat the same way as a staff in a watch, and on its extreme upper end it carries an indicating needle *D*. The needle is retained at zero by means of the flat spring *E* and a hairspring *F*. The dial *G* is divided into twenty-five equal parts, the distance between each graduation representing a movement of the lever *B* of 0.001 inch. The dial is so arranged that it can be turned around to bring the zero point in line with the needle when the latter is at rest. In this instrument the objectionable feature of backlash is avoided, and it has been found both reliable and sensitive. A plate, not shown, covers the internal mechanism by fitting in a dovetail groove in the side

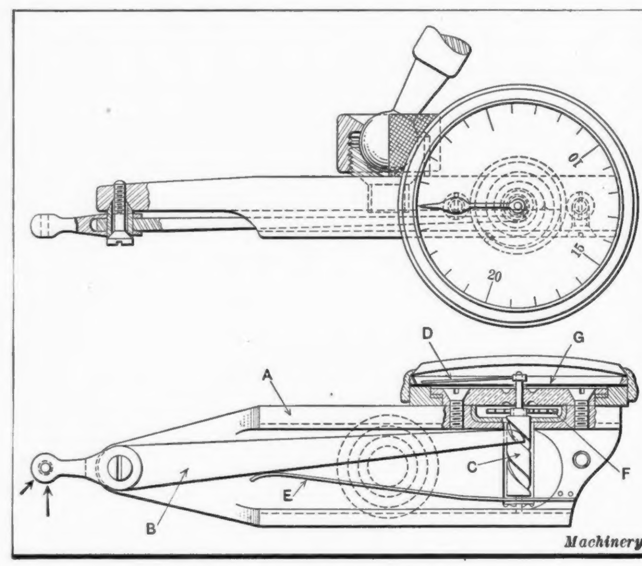


Fig. 21. Lowe Dial Test Indicator

of the body and is held in place by a screw. By the addition of several arms, etc., this device can be used for various purposes.

Dial Indicator of the Caliper Type

Another dial indicating gage which does not depend for its magnifying movement on a train of gears is shown in Fig. 22. In this gage the hand *A*, which travels around the dial, is operated by means of a fusee chain that is wound around the spindle, to which the hand is fastened and is connected to the movable jaw lever *B*. A hairspring, not shown, surrounds the lower end of the spindle to which the hand is attached in such a way as to pull the indicator hand toward zero and keep the chain wound up as far as the caliper jaw will permit. The jaws are separated by pushing the button *C* to the right, which operates the long lever *B* attached to the movable jaw.

Micrometer Indicating Gages

An indicating gage which is capable of wide application is the micrometer type of gage. This generally consists of a micrometer spindle held in a suitable frame, which as a rule also supports the work and enables measurements to be taken at several points when desired. A simple application of the micrometer type of gage is shown in Fig. 23; this is used for

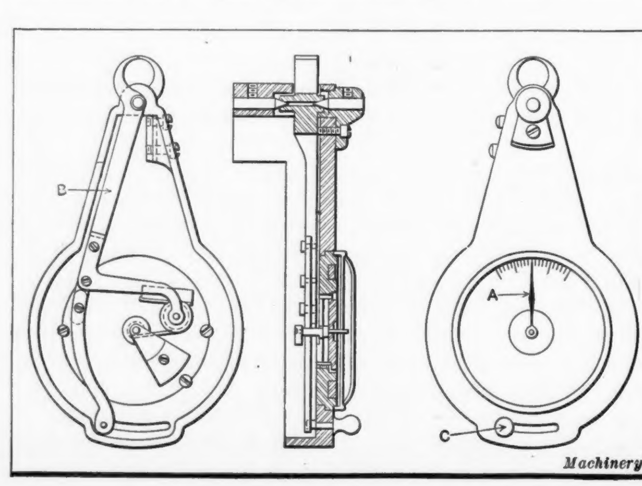


Fig. 22. Dial Indicator of Caliper Type

measuring the diameter of a military rifle bolt at the root of the spiral ribs. It consists principally of a frame *A* holding a split sleeve *B* and a micrometer spindle *C*. The sleeve *B* is held on a conical plug *D* by a nut and is split so that it can be made to fit snugly in the hole in the bolt. To lay off the manufacturing limits on the gage, the master plug *E* is placed on sleeve *B*, and the measuring point *F* is brought in contact with it. This master plug *E* is also used for checking up the gage at frequent intervals.

Another interesting type of micrometer indicating gage is shown in Fig. 24. This is used for testing the location of the guide in a receiver for a military rifle. The receiver is held in a gaging fixture, being located by plugs fitting in both ends. The upper surface of the fixture is provided with hardened and ground parallel strips, on which the micrometer gage is located, as shown. The gage consists of a base *A* provided with a lug which fits against the hardened and ground meas-

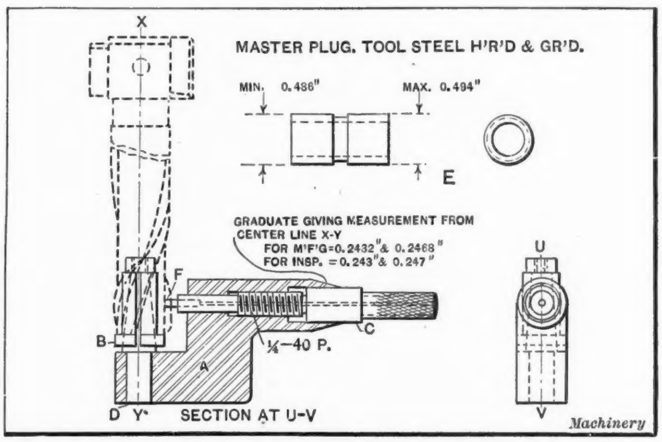


Fig. 23. Micrometer Type of Indicating Gage used for testing Rifle Part

uring blocks on the stand. A cone pointed and threaded spindle *B* extends downward through the center of the body of the gage and actuates a measuring finger *C*. This finger is held by means of a flat spring *D*, shown in the lower view, which fits in the slot in the finger and also in the base of the gage. A cap *E* is fastened to the stem of the gage by two screws, as shown, to prevent the finger *C* from dropping out. The spindle *B* is provided with forty threads per inch and is pinned to a thimble *F*. The graduations on this thimble are laid out after the gage has been assembled and set by means of a master.

A somewhat similar micrometer gage is shown in Fig. 25. This gage, however, is used for testing the distance from the center of the receiver to the bottom of the bolt sleeve guide slots. A stand similar to that used with the gage shown in Fig. 24 is used with this gage for holding the work; this gage

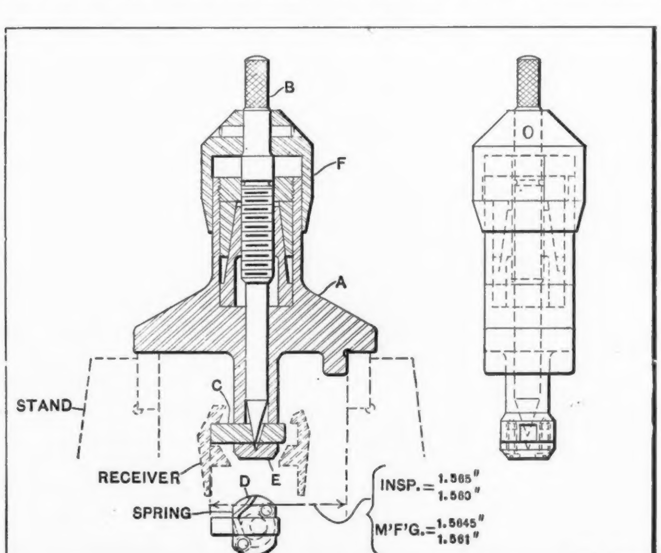


Fig. 24. Micrometer Gage for testing Location of Bolt Guide Groove in Military Rifle Receiver

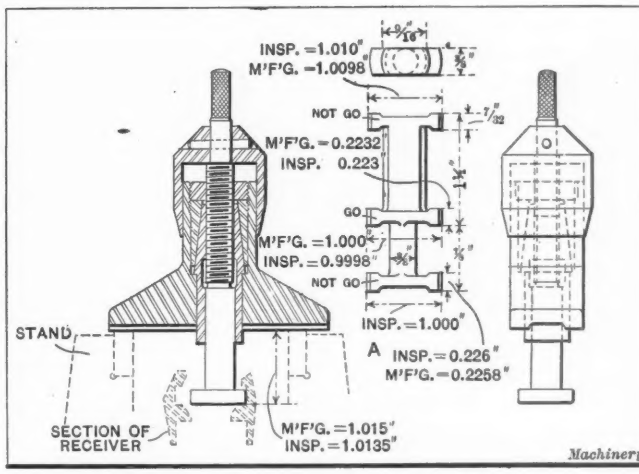


Fig. 25. Another Micrometer Gage for testing Bolt Guide in Military Rifle Receiver

is of practically the same construction as that shown in Fig. 24 except that the spindle is provided with a head which acts as a measuring point. A standard reference block is provided for use in setting the spindle when it becomes worn or inaccurate.

There are, of course, many other applications of the micrometer spindle to accurate gaging, but the examples presented here show some of the principles involved which are subject to considerable modification.

Three-point Indicating Gages

In machining work which is eccentric or unbalanced, considerable difficulty is sometimes experienced in producing a

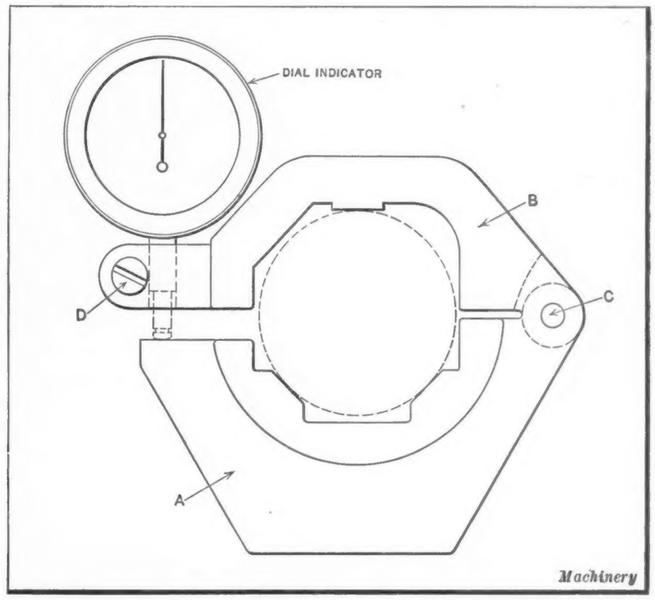


Fig. 26. Three-point Dial Indicating Device for testing Crankshaft Bearings

truly cylindrical hole or bearing, due to play in the machine bearings or other causes. When the forces opposed to each other are so unbalanced that a three-cornered effect is produced, the ordinary two-point measuring instrument will not detect the error that exists. The only way of successfully measuring the work to find whether it is truly cylindrical or not is to employ a three-point measuring instrument. Several devices have been made for this purpose, one of which is the ordinary micrometer provided with a special two-point anvil, the third point being formed by the spindle of the micrometer.

Another device which employs a dial indicator is shown in Fig. 26. This is used for measuring the crankpins of automobile crankshafts and, as shown in the illustration, consists principally of two blocks *A* and *B* hinged at the point *C*. The upper block *B* is machined on one end to receive the spindle of the dial indicator, which is held in place by means of the screw *D*. In use, the indicator is swung open, slipped over

the work and then brought down in contact with it, so that the spindle rests on the upper surface of the block *A*. It is then possible to tell whether the bearing is out of round or of the correct diameter. The gage, of course, is set to the zero point by means of a master plug made to the same diameter as the crankpin.

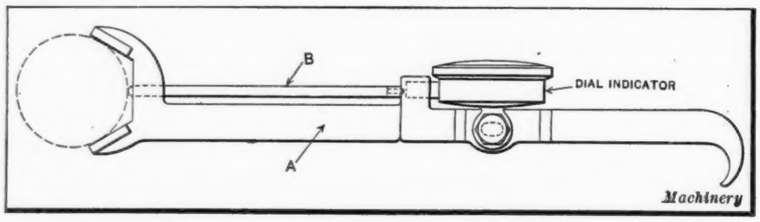


Fig. 27. Three-point Dial Indicator for testing Crankpin Bearings, which can be applied while Work is in Motion

The three-point indicator illustrated in Fig. 26 has one disadvantage in that it is comparatively slow to operate and is rather bulky to handle. An improvement over this device, which has three points located 30 degrees apart, is shown in Fig. 27. This device is also used for testing the crankpin bearings of a crankshaft and is so constructed that it can be used very rapidly. In fact, it can be applied to the work while the latter is in motion. It comprises a main holder *A* formed at the forward end to hexagonal shape and carrying two hardened, ground and lapped blocks, as shown. The rear end of the holder is provided with a hook to facilitate gripping in the hand. The dial indicator, as illustrated, is fastened to this holder, and coming into contact with the spindle of the indicator is a special spindle *B* passing through two bearing supports in the holder proper. In use, this instrument is set to the desired diameter by means of a master and then can be applied directly to the work while the latter is in motion and the reading taken off on the dial indicator. For many classes of work this type of instrument will be found to be much superior to the micrometer caliper in that it is quicker to operate and can be used in connection with the limit system of manufacture.

Fig. 28. Hirth Minimeter fitted up for Use as an Internal Gage

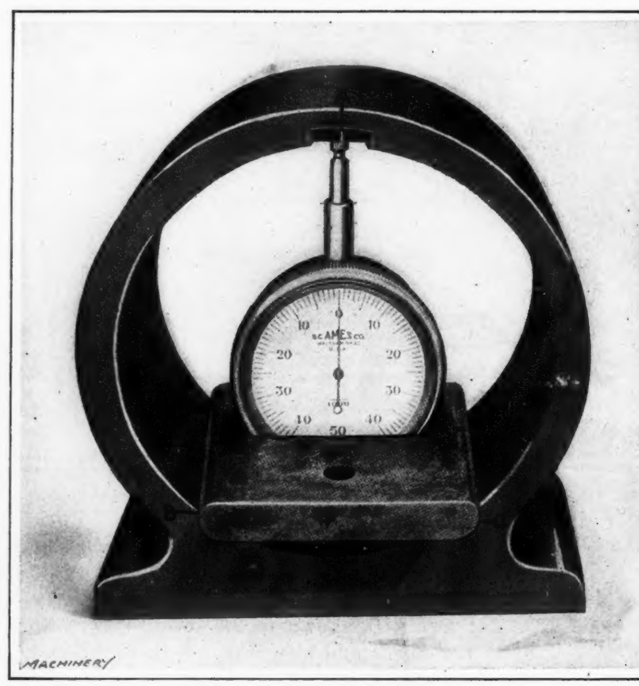


Fig. 29. Ames Gas Engine Cylinder Gage

Three-point Indicators for Internal Work

The indicating devices shown in Figs. 26 and 27 are used for external measurements. Fig. 28 shows a device which can be used for internal work. By the addition of a simple attachment, the Hirth minimeter, which has previously been described, is here used for internal gaging. The special holder is fitted around the body of the lower portion of the indicator, and carries one adjustable and two rigid points, the former being connected by means of a lever to the spindle of the indicating lever. Fastened to the bracket of this attachment are three rolls, against which the work is pressed, and which keep it straight while it is being tested. The two rigid points are adjustable for wear, and all three points are provided with ball points. With this device it is possible to tell whether the hole is of the correct size, or is out of round, tapered, etc.

Ames Gas Engine Cylinder Gage

A three-point dial indicating gage designed particularly for testing the bore of automobile cylinders is shown in Fig. 29. The illustration shows the gage inserted in the standard ring which is used for setting the needle at zero; this ring, of course, has a diameter equal to that of the cylinder it is desired to test. The base, holding the Ames dial indicator, forms two points, *B* and *C*, and the plunger of the indicator forms the third point *A*. With this device it is possible to tell whether the cylinder is large or small, out of round or tapered.

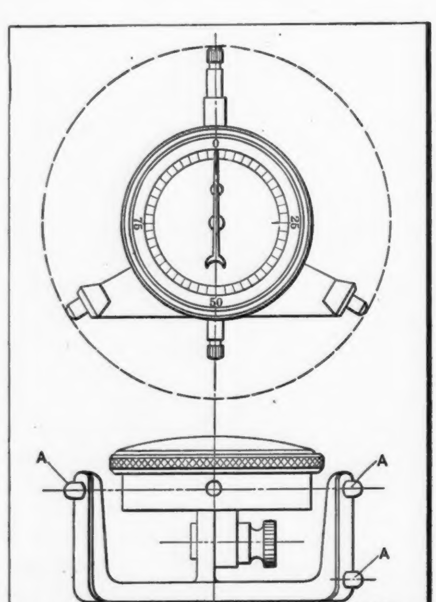


Fig. 30. Gas Engine Cylinder Gage having a Three-point Bearing on Its Base

Another three-point gas engine cylinder gage of simple construction is shown in Fig. 30. This gage comprises a standard dial test indicator, which is attached to a frame by a thumb-nut, as shown. In this frame, which is made of cast iron, are set three buttons *A*, two on one side and one on the other, giving a three-point bearing. The bearing points are set about 120 degrees apart, and two of the opposite points and the plunger of the dial gage are set in the same plane, the third being set lower a distance equal to about

one-third of the cylinder diameter. The dial gage is provided with a slip ring, so that the pointer may be set to zero no matter what its position may be. In using this instrument, it is pushed into the cylinder, dial first, from the head or compression end, assuming that the cylinder head is detachable. Then, with the aid of an electric flash light, the operator or inspector may easily watch the variations in the cylinder diameter. The instrument should be shoved through the cylinder slowly, care being taken to have all three corners bearing on the cylinder bore. If it is desired to use this instrument as a micrometer, it can be set by a standard ring.

Pratt & Whitney Star Gages

A type of gage which was developed especially to meet the demand for a convenient and accurate instrument for gaging the bores and jackets of guns of all sizes, from the one-pounder rapid-fire gun up to the largest caliber, is shown in Fig. 31. This gage consists principally of a body *A*, in which three measuring heads are held (four can be used if desired); these heads are radially adjustable, having tapped holes in the outer end to which various measuring points of any suitable length can be attached. The radial adjustment of the points is controlled by a central wedge or cone, which may be moved longitudinally, and the heads are fitted so that they may rotate freely when gaging the rifling of a gun or may be locked for regular work. The body of the gage is made of seamless drawn steel tubing, provided with means for readily coupling and uncoupling to produce any desired length. The tubular body *A* is graduated throughout its entire length in quarter inches. This is essential when it is desired to make a record of the condition of the bore by taking measurements at regular intervals.

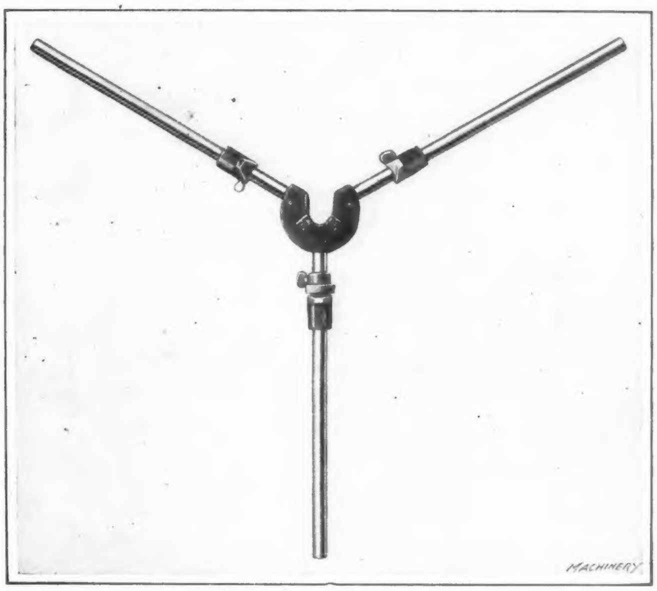


Fig. 33. Centering Device used with Pratt & Whitney Star Gages

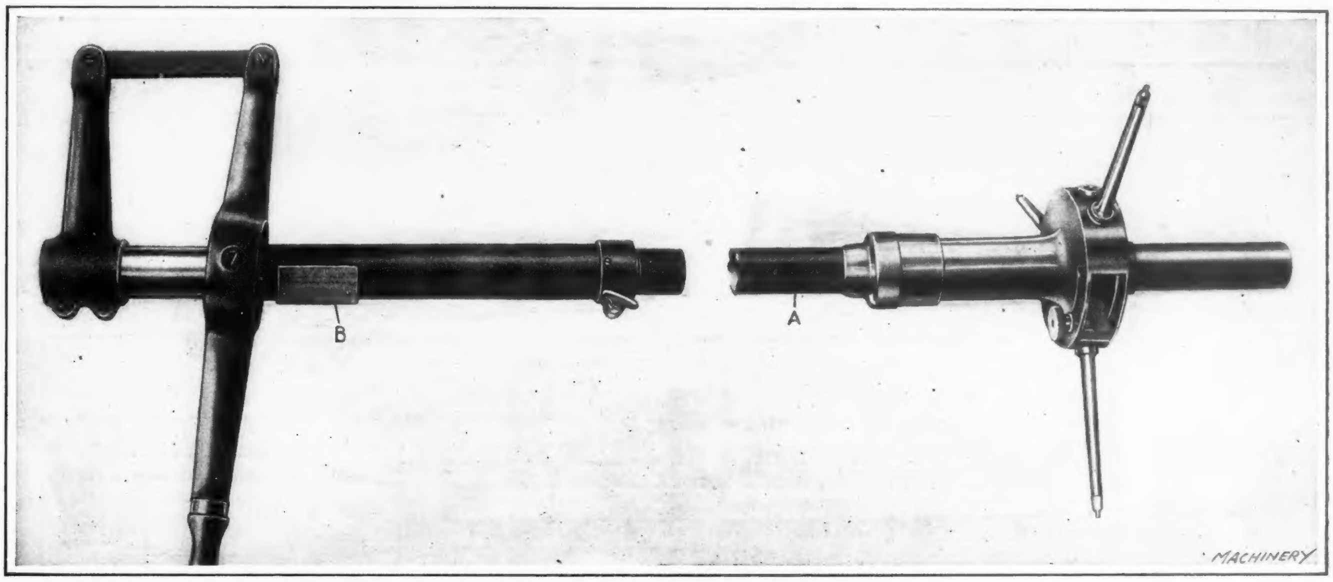


Fig. 31. Pratt & Whitney Star Gage with Three-point Measuring Head

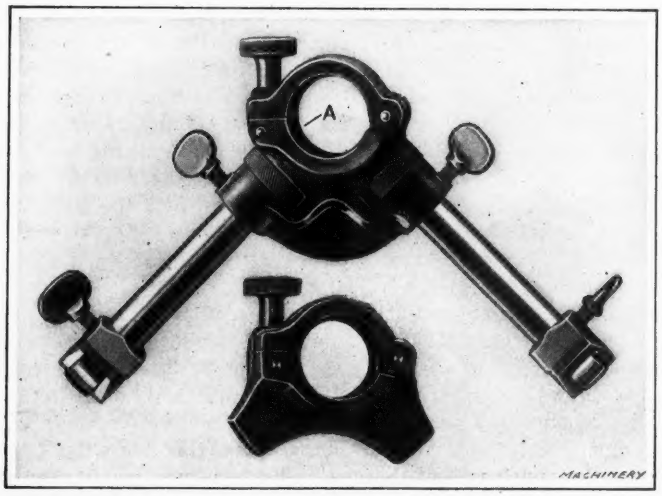


Fig. 32. Supports used for steadying Pratt & Whitney Star Gage when used in Long Lengths

The operating head shown to the left in Fig. 31 is made with a sliding member connected to the jointed rod by which the wedge in the measuring head is given its longitudinal movement. The operating lever shown is provided to give the necessary delicacy of movement, and also facilitates the operation of the gage. The scale and vernier shown at *B* enables the variations from the required diameter of bore to be read at a glance. For each diameter of bore to be gaged, a standard ring is usually furnished for setting the gage. Suitable supports hold the standard ring concentric with the measuring head when the points are brought in contact with it, and then the vernier is adjusted so that the zero lines coincide. For the smaller gages the vernier gives readings to 0.0005 inch, and to 0.001 inch on the larger sizes.

When gaging bores of considerable length, it is necessary to support the gage and to keep it from sagging, which would introduce a small error in measurement. Therefore, supports such as shown in Fig. 32 are used. These are set in the bore of the gun being measured and the gage is slipped through the hole *A*. The legs of the supports are then adjusted so that the gage is held central with the bore of the gun. A centering device, as shown in Fig. 33, is also provided when desired. This consists of a central hub with three graduated radial arms, upon which are mounted sliding jaws that project into the bore; one of the jaws is provided with a screw adjustment for binding the device in the bore. The central hub has a slot at the top to receive the gage tube which rests on two rollers permitting the gage to move freely without danger of marring the surface of the tube.

DRAW TOOLS FOR AUTOMOBILE SIDE RAILS

BY P. BALDUS[1]

A common form of automobile side rail is shown in Fig. 1, and the tools used in its production are indicated in detail in Fig. 2. Work of this kind is frequently done on a very heavy type of hydraulic press or on one of the heavier types of drawing presses. Referring to Fig. 2, it will be seen that the back die walls *A*, *B*, *C* and the front die walls *H*, *I* and *J* are made of cast iron, well ribbed to withstand the pressure to which they are subjected. The back die walls are fastened with screws *O* to a die shoe *D*, which is also made of cast iron. The clamps *K* and screws *N* are used for holding the front die walls securely, adjustability for these walls being secured through the screws *L* which are locked by the nuts *M*. The number of clamps and screws necessary to hold the front die walls depends somewhat upon the size of the work. The punch sections *E*, *F* and *G* are made of cast steel and lined up by keys at *S* as indicated.

[1] Address: 928 Right St., Milwaukee, Wis.

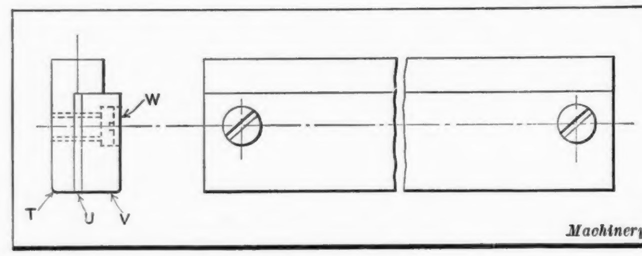


Fig. 4. Detail of Adjustable Punch

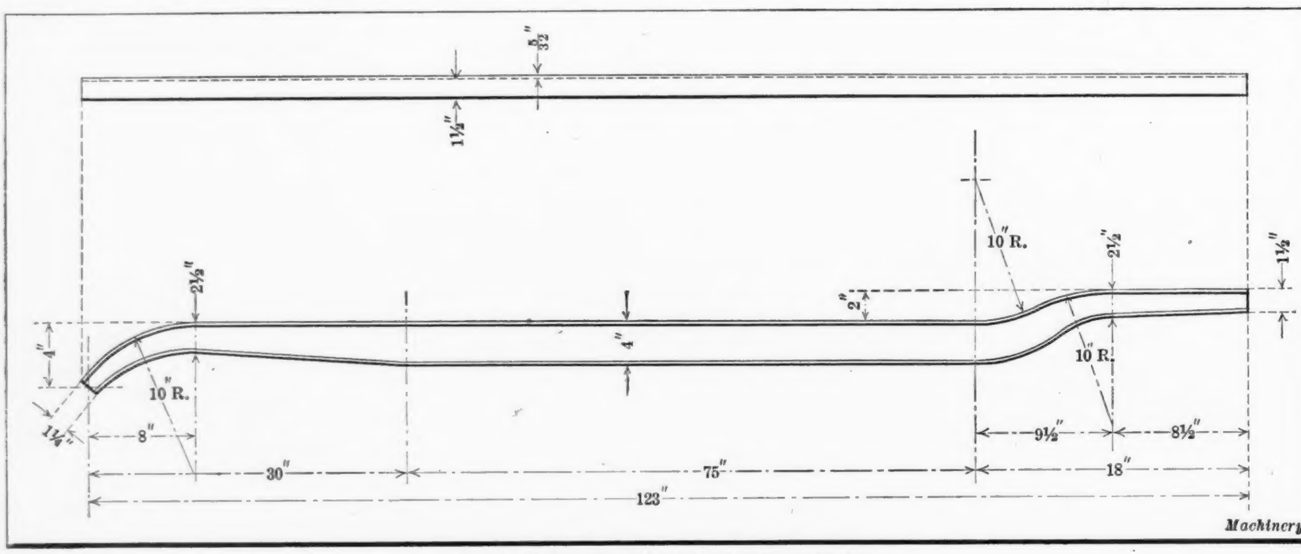


Fig. 1. Automobile Side Rail of Ordinary Design

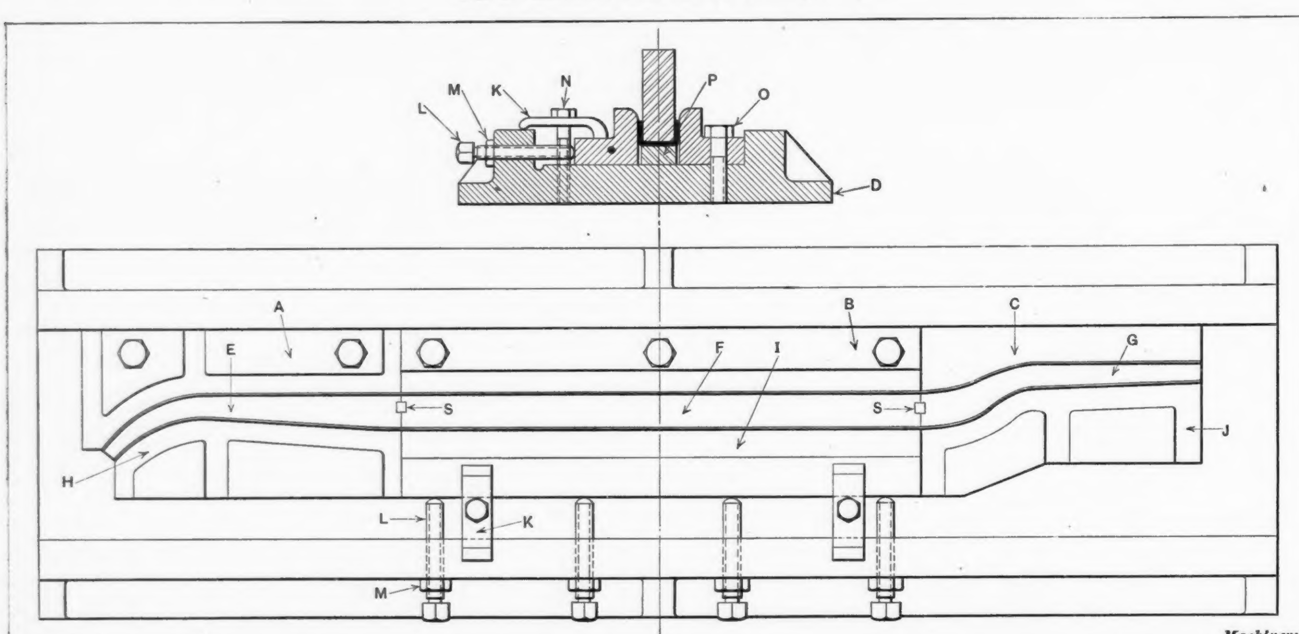


Fig. 2. Construction of Dies for Automobile Side Rail shown in Fig. 1

DRAW EDGES FOR CROSS AND SIDE BAR DIES	
THICKNESS OF STOCK	RADIUS "R" OF DIE
⅛"	¼"
$\frac{5}{32}$"	⅜"
$\frac{3}{16}$" AND OVER	½"

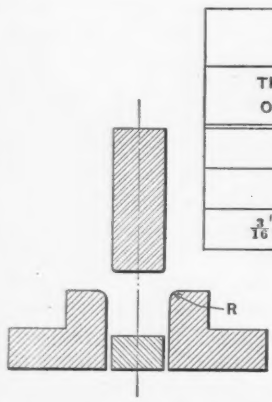


Fig. 3. Proper Radius for Drawing Edges of Cross and Side Bars

Fig. 4 shows an adjustable punch section as used by the A. O. Smith Co., Milwaukee, Wis. This punch consists of a punch-holder *T*, punch lining *V* and shim *U*. These three parts are screwed together with the screws *W*. It is evident that this construction permits the punch to be used for many different sizes of side rails by merely changing the shim *U* so that the punch will fit the new rail. The knock-out *P*, Fig. 2, is made of machine steel and is operated by knock-out rods.

When drawing the metal across the edges of the die, the thickness of the metal makes considerable difference in the size of the radius which can be used to advantage. The diagram and table shown in Fig. 3 give the proper draw edge radius for the various thicknesses of stock in common use.

* * *

WATCHING THE METERS

In the September number of MACHINERY an article was published on "Common Cause of High Electric Power Bills," and it seems to me that a few more causes might be added to those already given. The high cost of electric power is due in many cases to uneconomical methods and unscientific lay-outs. Even without instruments, a shop management can check up on losses which occur so slowly as to be unnoticed. The meter is the check. Running idle for a short period once every six months and taking a meter reading will show whether the shafting is getting out of line or is "pulling harder." Shutting off motors promptly and not starting until ready will effect quite a saving. Overtime work increases a bill. In one shop, light and power meters are read "before and after," and this amount is added to the bill just as for any other material. The same thing is done with the gas; in figuring the cost of a job that requires the use of a gas furnace or forge, the charge for so many cubic feet is added. This is as it should be, for no shop charging, say, seventy cents per hour can afford to throw in thirty cents per hour for gas.

Fuses may greatly increase an electric bill. Overloaded motors, underfused circuits, and careless workmen are responsible for this loss. When the writer was visiting a planing mill, he was shown a ten-horsepower motor driving an exhaust blower that gave continual trouble with blown fuses. Besides, the motor ran too hot all the time, so the mill owners had decided to replace it with a larger size. A study of conditions, however, showed that while the motor was overloaded, the blower was not, so it was recommended that the speed of the blower be reduced one-third. This change proved to be the solution to the problem, and a substantial saving was effected in the power bill. The writer believes that many blowers in planing mills and pattern-shops, and many grinder exhaust systems could be run slower, for the reason that it is common to install over-size blowers. D. A. H.

REVERSING PLANER MOTORS

BY C. C. GRAY[1]

Planers do not operate economically for all jobs, and even on a single kind of work a change in cutting tools or in the hardness of the metal often makes a change in cutting speed desirable. For instance, when cutting chilled castings it is necessary to operate the planer for the roughing cut at a low speed and for the finishing cut at a higher speed. This cannot be accomplished with belt-driven planers except by means of complicated speed-changing devices, and such devices will only permit a few speed changes to be made. Furthermore, with a belt drive, the countershafts and belts run much of the time while the planer is doing no work; *i. e.*, between jobs and while setting up work. Direct-connected reversing planer motors with automatic control permit a flexibility of speed adjustment which cannot be equalled, and which is only limited by the number of control steps provided; the cutting and return speeds of the planer can be promptly adjusted to the maximum speed permissible for any job. The operating expenses of a machine tool can be listed under four heads, *viz.*, interest and depreciation on machine; cost of power; miscellaneous expense; and supervision and clerical work. The hourly cost of operating various sizes of planers, as determined by data compiled in a shop using a number of these machines, is indicated in the accompanying table. The item of miscellaneous expense includes general repairs, storage, haulage, tool-room charges, and the interest and depreciation on cost of buildings and auxiliary apparatus. The figures are based on 2800 hours' annual operation. In practical operation, reversing motor equipments have, in most cases, increased the output of planers by 33 per cent or more, thus reducing by that amount both the labor charge and the machine overhead charges.

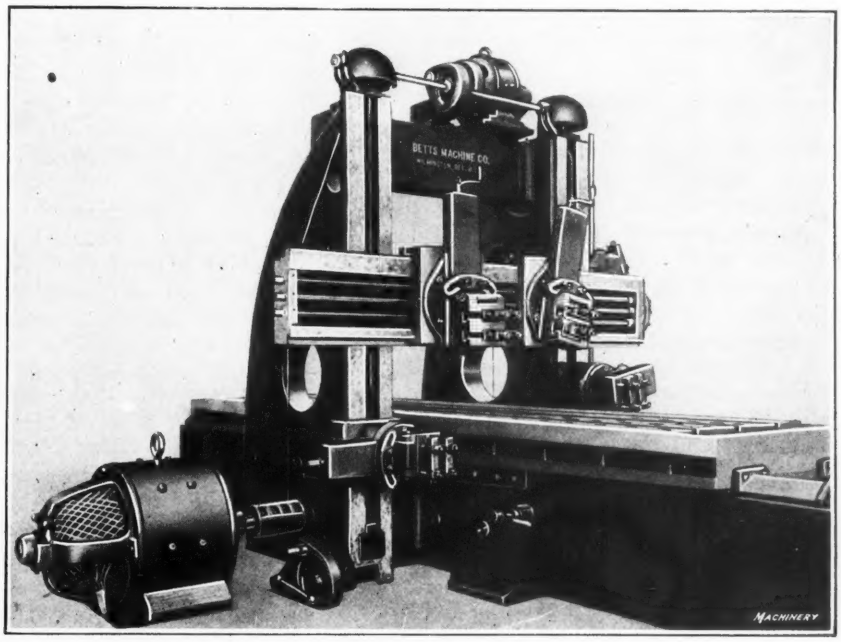


Fig. 1. Westinghouse Reversing Planer Motor, 20 H. P., 250 to 1000 R. P. M., driving a 48 by 12 by 12 Betts Planer

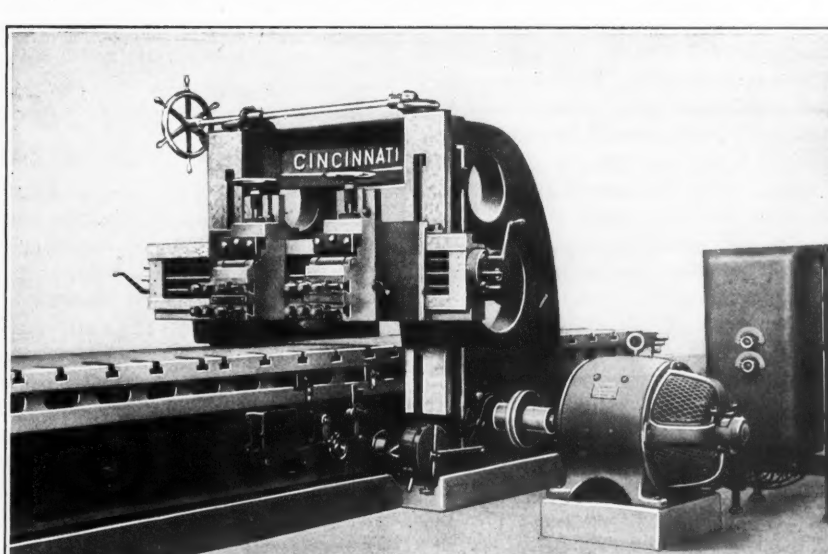


Fig. 2. Westinghouse Reversing Planer Motor, 50 H. P., 250 to 1000 R. P. M., driving a 48 by 24 by 20 Cincinnati Planer

The economies effected by the use of reversing planer equipments all tend toward increased production at a lower cost. The advantages may be classed as given below, and it will be apparent that each item has a definite bearing on increased production, which is the result desired.

1. Adjustment of speeds. Production is increased because the maximum speed is readily obtainable by a simple operation of adjusting the

[1] Address: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

HOURLY OPERATING EXPENSE OF STANDARD PLANERS WITHOUT REVERSING MOTOR EQUIPMENT

Width of Planer, Inches	Interest and Depreciation	Cost of Power	Miscellaneous Expense	Supervision and Clerical Work	Total Machine Hour Rate
36	$0.04	$0.02	$0.49	$0.25	$0.80
48	0.12	0.02	0.59	0.30	1.03
56	0.09	0.04	0.69	0.35	1.17
60	0.18	0.04	0.70	0.35	1.27
84	0.19	0.04	1.05	0.53	1.81
120	0.28	0.04	1.26	0.64	2.22
120 heavy	0.82	0.06	2.04	1.13	4.05
130	0.22	0.06	2.68	1.35	4.31
168	0.60	0.06	2.79	1.42	4.87
168 heavy	0.97	0.06	3.89	2.14	7.06

Machinery

field rheostat. This applies equally to the cutting and return strokes, independently of each other.

2. Time saved in setting up work. This saving is accomplished because all the movements of the planer are under accurate control of the operator at all times. After the work is properly located on the platen, by simply pressing a button in the pendant switch, the platen may be "inched" along and the tool located at its proper position with the minimum amount of time and attention from the operator, whereas with belt-driven planers the operator must manipulate a belt-shifting device until the work is properly located under the cutting tool, so that it can be set at the right angle and position in the toolpost.

3. Elimination of time and power losses due to belt slippage. On belt-driven planers there is a certain amount of belt slippage at the end of the cutting and return strokes. This cuts down the number of strokes per minute, because it is impossible to keep the belts tight enough to prevent slippage. Also, power is lost at these times. In contrast to this, with the reversing planer equipment the motor is directly coupled to the planer mechanism, thus eliminating all loss of time and power which is an objection to the belt-driven planer; the motor reverses at the end of each stroke and is immediately stopped and accelerated in the reverse direction at the greatest possible speed. Further, there is no slow-down due to belt slippage under heavy load. This is a very important point, as it becomes quite troublesome when the machines are carrying heavy overloads. If belts are tight enough to prevent slippage, their life is so short that the upkeep and maintenance charges on the planer equipment are almost prohibitive. Thus the time and power losses due to belt slippage, countershafting and tight and loose pulleys are eliminated. On heavy planers this is particularly important, since the repairs cost considerable and the belting is very expensive. Furthermore, the elimination of time required to make these repairs is an important point, as the machine is out of production service while these repairs are being made. This point in itself highly recommends the reversing planer equipment.

4. Saving in power requirements. While the cost of power in proportion to maintenance charges, labor, interest and depreciation is small, it is a point which should be considered. The power required in connection with reversing planer equipments has been found by actual test to be materially less than on a belt-driven equipment doing the same work.

The motor which is a part of the reversing planer equipment illustrated in Figs. 1 and 2 has been designed after a thorough study of the requirements of planer drive. The armature of the motor is designed with a very small diameter, which reduces the flywheel effect to a minimum, and it is this characteristic which permits the equipment to reverse in minimum time and enables the planer to take care of short-stroke work without distress on the part of motor or control. Perfect commutation is secured under all conditions of operation. The control equipment consists of a controller, a master switch and a pendant switch. The controller is mounted at any convenient place near or on the planer. The pendant switch is usually placed over the platen so that it can be held in the operator's hand while he is observing the cutting operations or measuring the work. The master switch is mounted on the planer bed and is tripped by dogs attached to the platen.

When the "run" button on the pendant switch is pressed, the motor starts and automatically accelerates to a speed corresponding to the setting of the control. When the end of the stroke is reached, the master switch is tripped and the motor stopped by dynamic braking and immediately started in the reverse direction, accelerating to the proper speed. This cycle is repeated over and over again until the "stop" button on the pendant switch is pressed. The cutting and return speeds can be adjusted independently and within wide limits, so that the speed can be used which gives the maximum production for any length of stroke, depth of cut, or weight of platen. For the average planer the platen speed can be adjusted between the limits of 25 and 50 feet for the cutting stroke (motor speed, 250 to 500 revolutions per minute) and between 50 and 100 feet per minute for the return stroke (motor speed, 500 to 1000 revolutions per minute).

The equipment illustrated employs dynamic braking for stopping at the end of each stroke. Since the current used for the dynamic braking is generated by the motor itself and not taken from the line, a minimum amount of power is required for the operation of the planer. Oscillograph records show that the maximum currents drawn, both at the time of dynamic braking and at the instant of reversal, do not exceed 1¼ times full load current of the motor, so that there can be no objection to putting a reversing planer equipment on any shop circuit.

* * *

STATISTICS OF STEAM RAILWAYS

Statistics of the steam railways in the United States for the year ended June 30, 1915, as given in a report of the Interstate Commerce Commission, show the following figures. The roads covered by this report, which does not include switching and terminal companies, represent 257,569.32 miles of line operated, including 11,279.64 miles used under trackage rights. The aggregate mileage of railway tracks of all kinds was 391,141.51 miles. These figures show an increase of 3933.20 miles over those given for 1914. There were 65,099 locomotives in service on the various railways. The total number of cars of all classes in service was 2,507,977, assigned as follows: passenger service, 55,705; freight service, 2,356,338; company service, 95,934. The roads covered by the report are divided into three classes: Class I roads are those having annual operating revenues above $1,000,000; Class II roads are those having annual operating revenues from $100,000 to $1,000,000; and Class III roads are those having annual operating revenues below $100,000. Class I and Class II roads, operating 224,858.89 miles of line, reported 1,409,342 as the average number of employes in their service during the year. The total wages paid during the year by roads of the same classes, operating 224,371.01 miles of line, were $1,164,844,430. The number of passengers carried on Class I and Class II roads in 1915 was 976,303,602, as compared with 1,053,138,718 in 1914. The operating revenues of railways in the United States were $2,956,193,202, or $11,538 per mile of line operated. The operating expenses were $2,088,682,956, or $8152 per mile of line operated.

* * *

PLATINUM SUBSTITUTES

A substitute for platinum must satisfy the following conditions: Its melting point must be well above 1200 degrees C.; it must not be affected by chemical compounds formed in its application; nor should it oxidize at a soldering temperature; it must possess sufficient strength to resist deformation and at the same time be sufficiently pliable to be worked to the desired shape; its coefficient of expansion must be low; it should readily unite with gold, silver and other metals, and their solders; its cost should be low as compared with platinum. In the electrical industry platinum has largely been replaced by tungsten, molybdenum and nickel-chrome alloys. Various alloys have been perfected to meet different conditions under which platinum was formerly used. One of the latest is a copper-jacketed nickel-steel wire, having an outside coating of platinum. This wire is said to have a coefficient of expansion which is such that in feeding an incandescent lamp a tight joint is assured.

CHART FOR SELECTING RAWHIDE PINIONS

BY N. G. NEAR

Fig. 1 shows a chart which will be found useful in selecting rawhide pinions to replace metal pinions that have proved unsatisfactory in service. It is used by simply laying a straightedge across the chart three times, which solves the problem without the necessity of doing any figuring. For example, suppose it is desired to replace a noisy metal pinion with a quiet-running rawhide pinion, and it is desired to find out whether a given pinion is strong enough to transmit the power from a seven-horsepower motor; the pitch diameter of the metal gear is 4 inches, the circular pitch ½ inch, the face width 4 inches, and the motor runs at 1000 revolutions per minute. The dotted lines drawn across the chart illustrate the way in which the problem is solved. From 4 on column *A* for the pitch diameter, lay the straightedge across to 0.5 on column *C* for the circular pitch, and locate the point of intersection of this line with column *B*. Then from 4 on column *E* for the face width, lay the straightedge across to 1000 on column *G* for the number of revolutions per minute, and locate the point of intersection of the straightedge with column *F*. Now lay the straightedge across from the point of intersection on column *B* to the point of intersection on column *F*, and the point where the straightedge cuts column *D* for the horsepower transmitted will show the capacity of the rawhide pinion; in this case it is found to be 9.4 horsepower, which is more than sufficient to transmit the power developed by the seven-horsepower motor. It will be evident that where a pinion of wider face is required, the chart will show instantly that such is the case, and the danger of employing an unsatisfactory pinion is eliminated. Knowing any three factors given in columns *A*, *C*, *E* and *G*, the fourth one can be quickly found.

It is not a difficult matter to construct an alignment chart directly from a slide-rule; an alignment chart is a logarithmic chart, and a slide-rule is a logarithmic rule. Fig. 2 shows the principle of construction well enough to enable any reader who has a slide-rule or table of logarithms to develop a similar chart of his own. Column *A* is a direct copy of the 1 to 10 scale of a slide-rule, as is also column *C*. On my drawing I placed the lines three inches apart and parallel. Exactly in

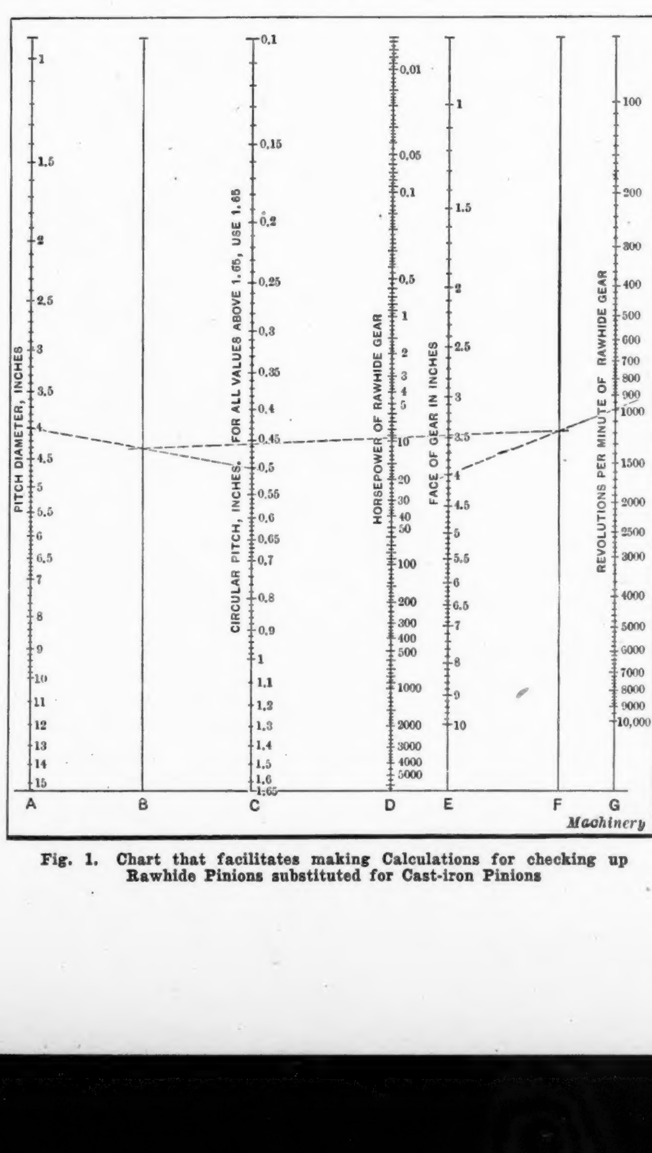


Fig. 1. Chart that facilitates making Calculations for checking up Rawhide Pinions substituted for Cast-iron Pinions

the middle between these two lines, I erected column *B*, and on it copied the 1 to 100 scale from the slide-rule, and placed it in such a position that the chart is nothing more nor less than a multiplication table. The dotted line drawn across the chart, for example, shows that $2 \times 3 = 6$; or the same dotted line would indicate that $6 \div 2 = 3$, or $6 \div 3 = 2$, as the case might be. By copying all the small lines from the slide-rule, the answer can be read more accurately, where fractional numbers are to be divided or multiplied by fractional numbers, as in the case of the "rawhide chart," Fig. 1.

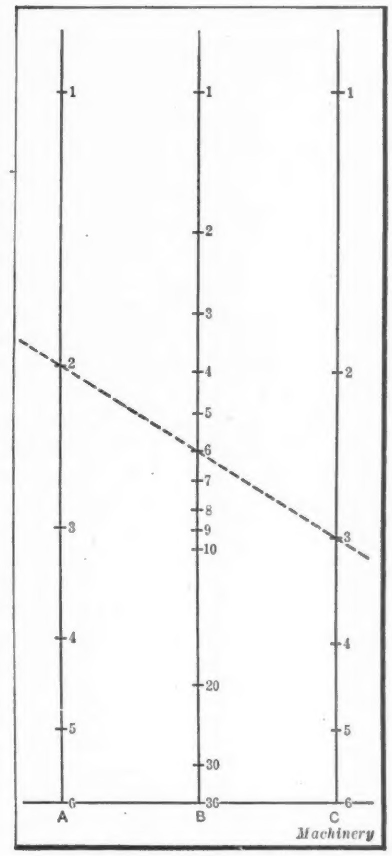


Fig. 2. Diagram showing Principle of Construction of Chart shown in Fig. 1

Now, suppose it should be desired to make a chart from the formula:

$$\frac{PV}{550} = \text{H.P.}$$

where P = pressure in pounds;

V = velocity in feet per second;

H.P. = horsepower.

Proceed as above by erecting columns *A* and *C*. If the pressures range from 1000 pounds up, insert the figures 1000, 2000, etc., instead of 1, 2, 3, etc. And if the velocities range from 10 feet per second up, do the same with the column that is to designate the velocity—either column *A* or *C*. Then lay a straightedge across the chart connecting two points, and figure what the middle column should read. That is, if $P = 11$ pounds, and $V = 100$ feet per second, H.P. will equal 2. The 1 to 100 scale of the slide-rule is then copied onto column *B* in such a way that 2 falls upon the point of intersection with the straightedge, and the chart is correctly made. In case it is desired to multiply H.P. by some other figure, this is easily done by extending the chart and adding more columns, the same principle being followed as before. The "rawhide chart," Fig. 1, is a good example of this, four figures being multiplied. I divided the multiplying process into two groups, as follows:

$$\underbrace{2 \times 3}_{6} \times \underbrace{4 \times 5}_{20} = 120$$
$$6 \times 20 = 120$$

The constant in the rawhide formula used was cared for in the manner explained. To be sure, all of these scales cannot be copied from a common slide-rule, but with the aid of a pair of proportional dividers it is easily done. The 1 to 100 scale on the slide-rule, for example, is a one-half reduction of the 1 to 10 scale. In case the range of figures should be such that we would need a 1 to 10 scale on column *A*, and a 1 to 100 scale on column *C*, it is plain that a 1 to 1000 scale would be needed on column *B*; but column *B* would not then fall exactly in the center, as on this multiplication chart: it would fall at a "third distance." That is, the distance *AB* would be two inches, and distance *BC* would be one inch. Column *A* would then be a full-size scale; column *C* a half-size scale; and column *B* a third-size scale. Proportional distances would be as follows: $BC = 1$; $AB = 2$, and $AC = 3$.

After studying this brief description of the method of making charts and application to the "rawhide chart," little difficulty will be experienced in making a similar chart on some other subject. Unless logarithms and the slide-rule are understood, it will be difficult to make charts of this kind; but understanding these subjects, as I believe all readers of

MACHINERY do, further details will be unnecessary. Should it be desired to study the subject more fully I would recommend J. B. Peddle's book, "Construction of Graphical Charts," or Lionel S. Marks' new "Mechanical Engineers' Handbook," which gives a good brief summary of nearly all methods of constructing graphical charts, including the one here described.

* * *

CATALOGUE INDEXING

When anyone picks up a catalogue for the purpose of looking up some matter presumably contained therein, he naturally looks for the subject in which he is interested according to the alphabetical arrangement in which it would most likely be found. For example, if a man were looking for information on the subject of milling machines of the Lincoln type, he would first look under the heading "Milling Machines, Lincoln Type," which should be found under "M." If the machine were not found under this alphabetical arrangement, due to a faulty method of indexing, one would look next under "L" for "Lincoln Type Milling Machine." Failing to find it under either of these heads, the next step would be to seek for the machine itself by looking through the pages of the catalogue.

Now an index is for one purpose and one only, and that is to give a seeker after knowledge the knowledge that he seeks, and unless it is arranged so as to give the seeker this information, it is without value as an index. There are a number of ways in which the index to a catalogue can be arranged so that the information contained therein will be conveniently accessible. There are other ways in which the information can be so classified that the only method of finding anything is to look entirely through the index until the part wanted is discovered. As a general thing, the preparation of catalogues is under the supervision of the sales or publicity department or the advertising department of the factory. The viewpoint of any one of these departments, in regard to the catalogue itself, is that it should be first, last and all the time, a medium by means of which the particular merits of the machines can be exploited. Under these circumstances the index naturally receives scant attention, and in some cases it is even left out altogether. When a manufacturer is advertising only one line of tools and has prepared a catalogue containing a very few pages, the index is not of great moment, because it takes little time to look through and find the information. On the other hand, a manufacturer who makes several different types of machines in a number of sizes, together with attachments of various kinds used in connection with these machines, should use every effort to make the index of his catalogue both comprehensive and convenient for reference. Under these conditions, there would seem to be little excuse for an index which does not fulfill these requirements.

A catalogue is not infrequently found in which the index is arranged by page numbers entirely, no attention being paid to alphabetical arrangement. For example:

	Page
Milling Machines, Single-spindle	3
Milling Machines, Duplex	7
Single-spindle Profiling Machines	14

and so on right through the catalogue. Now it is evident that where there is no alphabetical sequence anyone looking for any particular type of machine must go through the whole index in order to find it.

Another index of a type which is to be deplored is one in which the indexing is not done under the proper letters. For example, "Hand Milling Machine" might be found under "H," which would be all right providing there were a cross reference to it under "M" for "Milling Machine, Hand." Then again, there is the type of index in which there is an attempt at alphabetical arrangement, but where other data such as

No. 5 Milling Machine
No. 6 Milling Machine, or
Universal Milling Machine

come before the head under which the machine properly should be indexed.

Many manufacturers of the present day are issuing their catalogues in the form of leaflets, each one of which contains information on a certain type of machine. No doubt this is an excellent arrangement from the viewpoint of economy, and it is also very good for anyone wanting information on one particular thing. It is then unnecessary to look through an entire catalogue to find the machine desired, as all necessary data will be found in the leaflet. Going a step further, however, these leaflets are sometimes bound together to form a catalogue, a printed page or two being added for an index. When this is done, the index page serves no other purpose than to indicate the kind of machines contained within the outside covers, so that if anything is wanted a search through the pages must be made to find it.

It would seem that the index to any catalogue should be of sufficient value to take a little trouble with it in order to make it as comprehensive as possible, so that it would not be necessary to search through the book to find any desired information. As a suggestion, the following is offered in the hope that it may prove useful to those engaged in the preparation of catalogues:

1. Arrange index alphabetically according to the principal name of the machine tool or other mechanism.
2. Cross index under as many heads as may be consistent with the commonly accepted name of the mechanism.
3. Place the index either in the front of the catalogue or at the back—not in the middle.
4. When a number of leaflets are bound together to form a complete catalogue, either have the entire group of leaflets paged, with an index in the front, or put a table of contents in the front and place colored inserts between the various sections so that they can be easily distinguished.

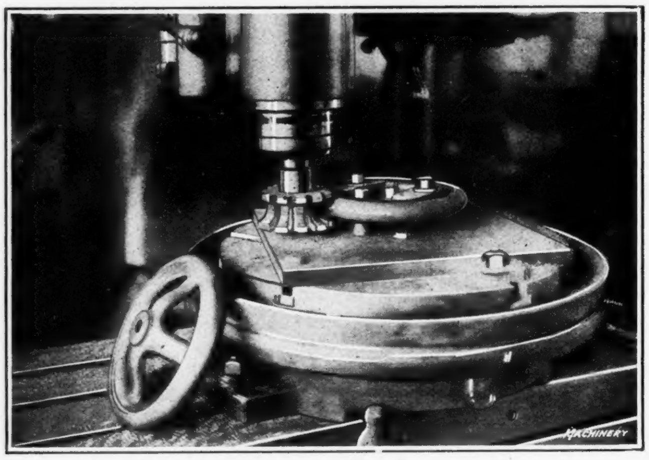
Any advertising, sales, or publicity manager will find it of advantage to look into the manner in which a new catalogue is being indexed and endeavor to arrange it so that it may be of some real use to a customer rather than a source of annoyance. A. A. D.

* * *

FINISHING HANDWHEELS BY MILLING

In the manufacture of contract machinery at the plant of the C. H. Cowdrey Machine Co., Fitchburg, Mass., a regular job is the machining of large numbers of handwheels. These particular wheels are 8 inches diameter, and the rim is 1 1/8 inch diameter. The ordinary way of finishing the rims of these wheels is to mount them on arbors in the lathe and turn off the exterior with a radius-turning attachment.

The accompanying illustration shows how these handwheels are finished in this factory by milling on a vertical milling machine. By mounting these wheels on the rotary table of a vertical miller and inserting a concave cutter in the spindle, they are finished at one revolution of the table. About 1/16 inch of metal is removed from the surface, and when the castings run uniform fifty wheels may be milled before it is necessary to grind the cutter. The result is a better piece of machining, and the operation requires less attention from the workman than when done by the old method. C. L. L.



Finishing Handwheels on a Vertical Miller

* * *

The wax of old phonograph records may be used with satisfaction on tracing cloth when erasures are necessary. The wax rubbed over the erased portion gives the paper a gloss and finish similar to the original surface and prevents the ink spreading in the lines.

MANUFACTURE OF AUTOMOBILE CUSHION SPRINGS[1]

MEANS AND METHODS OF FORMING, CONVEYING AND TREATING WIRE SPRINGS IN A MODERN PLANT

BY E. F. LAKE[2]

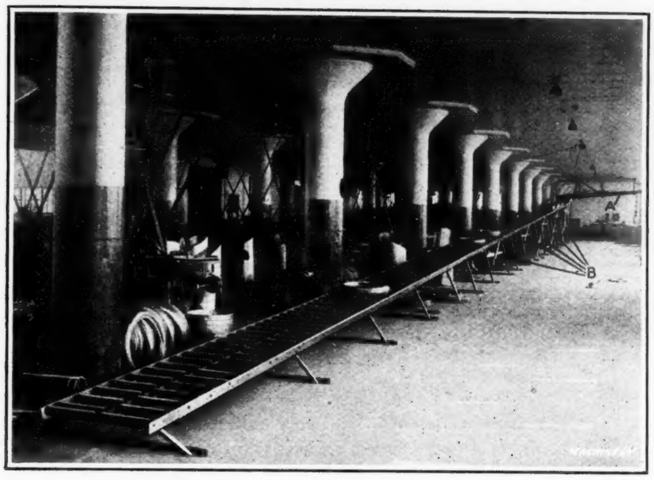


Fig. 1. Roller Conveyor on which Coils of Wire are brought into Shop

WHEN the Detroit Wire Spring Co., of Detroit, Mich., moved into its new building last November, it started to manufacture the seat and back springs for motor cars by methods that have eliminated hand labor to a great extent. Gradually other places were found where savings in labor cost could be effected, and now this firm is manufacturing at a minimum cost of production. For several years manufacturing was conducted in buildings that were not adapted for improved methods; and during this period L. A. Young, president of the company, had conceived many ideas that were awaiting the proper time to be given a practical application. When the company outgrew its old quarters, it built and equipped an entirely new plant from the ground up. This gave Mr. Young an opportunity to exercise his inventive genius to a marked degree, and the apparatus that was installed completely changed the process of producing such springs. This lowered the cost of production to such an extent that it is the talk of the spring-making industry.

Fig. 1 shows about half of the second floor of this new shop, and it is here that production may be said to start on seat and back springs for automobiles, or cushion springs for any other use. As this firm manufactures all the cushion springs used by the Ford Motor Co., one might think that the latter has had an influence on the Detroit Wire Spring Co. as regards the application of conveyor systems for handling work. After investigating the appliances in this shop, however, it will be seen that Mr. Young has advanced beyond the achievements of the Ford Motor Co.

In Fig. 1 is shown how the coils of spring wire enter the shop and are delivered at the various stations, where they are manufactured into springs by the coilers and knotters. These coils are loaded onto an elevating conveyor at the freight car on a track outside the building. This raises them to the second story and drops them onto the roller conveyor shown in the illustration. The coils then enter the building at *A*. After that they travel down over the rollers, as can be seen, and are dropped into chutes at the different points marked *B*. These chutes deliver the coils to the floor just back of the coiling machines, which can be seen at the left running in a long row through the center of the building.

The roller conveyor can be switched open at five different points to allow the wire to pass through chutes to the floor. Coils are needed at three other points below the lowest switch in the rollers, but at these stations the rollers are so low that the wire coils can easily be lifted off and thus switches are not needed. This roller conveyor is approximately 200 feet long and serves one-half of the shop, which is 400 feet long and 80 feet wide. Fig. 2 shows how the roller bed is broken to allow the wire to slide down chutes to the floor. Directly underneath at *C* is shown the reel of the coiling machine, on which the wire coil is placed to be made into springs. As the coiling machines form a line along one side of the columns and the conveyor follows the other side, the coils of wire drop to the floor within three feet of the spot where they are to be used.

Fig. 3 shows a close view of one of the coiling machines as it is set up ready for work and just about to cut off a spring which has been coiled. These coiling machines are manufactured by the Frank Wells Machine Co., of Kenosha, Wis. The spring wire in the coils is placed on reel *C* and passes into the machine through guide *D* and rollers *E*. Guide *D* has a set-screw to govern the tension of the wire, the same as the thread on a sewing machine. The diameter of the coils of the spring is governed by the wire passing through clamp *F*, which moves up or down toward a given center or away from it. This movement is caused by lever *G*, which rides on cam *H*. Thus, cam *H* is the only part of the machine that has to be changed for making different kinds of springs. Each size and shape must have its own cam, but to change these it is only necessary to manipulate one nut, shown on the side of the cam.

The only limit to the size and shape of springs that can be coiled is in the limitations of these cams, which are located where they can be given a larger diameter than would ever be required for springs of this kind. When the spring has the correct number of coils, tool *I* is tripped and cuts off the wire. The operator of such a machine only has to place the coil of wire on the reel, start it feeding into the machine, and grab the springs as fast as they are cut off. He then bunches them and puts them in the pan of truck *J*. This sounds easy, but the men are kept exceedingly busy and are paid by the piece. After watching them for a while one wonders how they can handle so many pieces and keep it up for ten hours every day. At many of these coilers troughs are arranged so the coilers can slide the springs to the knotting machines, where the second operation is performed. One coiling machine usually turns out enough work for two knotting machines.

In Fig. 4 is illustrated one of the knotting machines. At *K* is shown a sample of the spring that the pan contains, in the shape in which it is left by the coiler. Coiled springs would not be very successful if they were left in this condition, for when used in seats the ends would be likely to get as many cuss words as the boy with the bent pin. Hence, machines were invented for looping each end of wire around the coil below, so they would not cut through the upholstering. These loops, or knots, tied in each end of the wire spring, are shown on the spring at *L*. The operator of the machine first places the spring in the position shown at *M*, and the lower coil is then gripped by jaw *N*. Cam *O* controls its movements

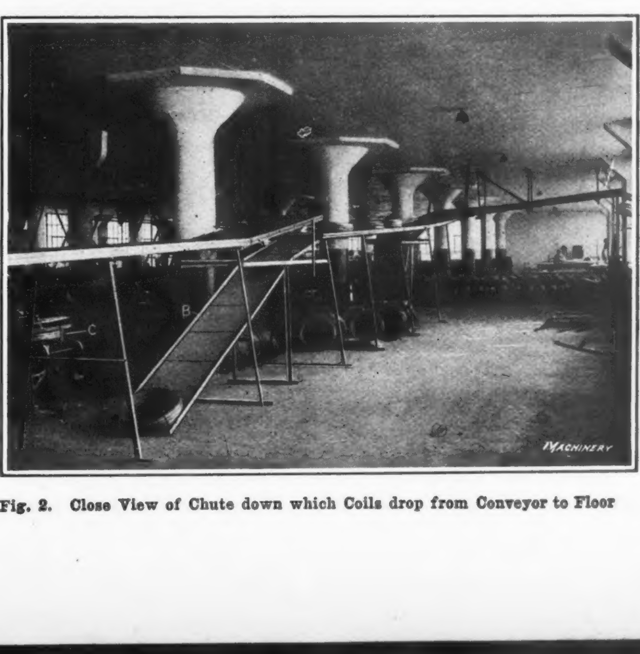


Fig. 2. Close View of Chute down which Coils drop from Conveyor to Floor

[1] For previous articles on spring manufacture, see "Automobile Cushion Springs" in the August, 1916, number of MACHINERY, and other articles there referred to.
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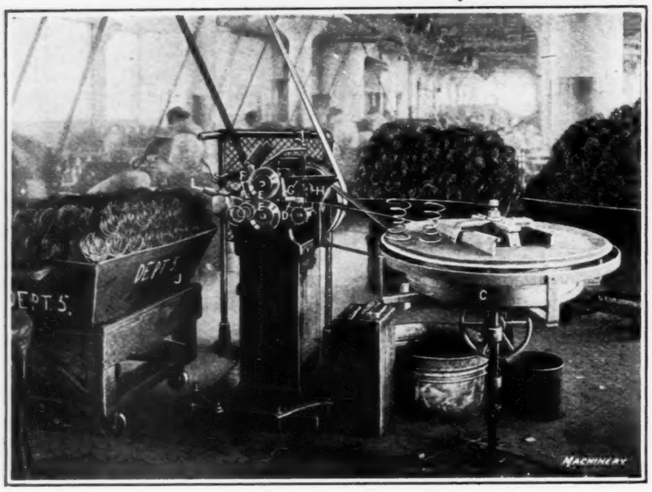

Fig. 3. Close View of Coiler with Spring ready to be cut off

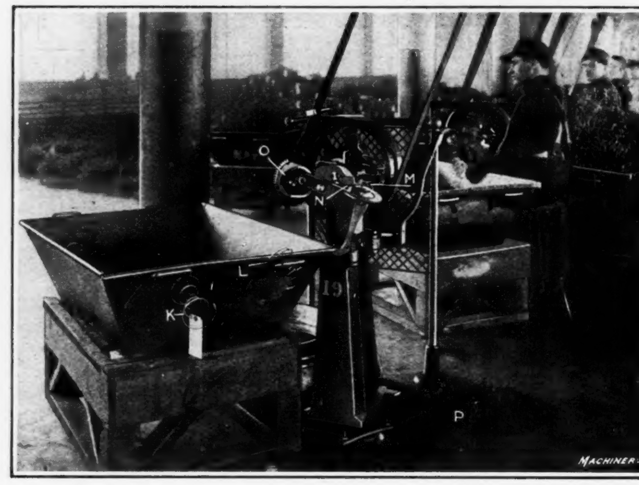

Fig. 4. Knotting Machine that secures Ends of Wire to Spring Coils

and also the movements of those parts of the machine that tie the knots. When the knots are tied, the operator merely drops the springs into a hole in the floor at *P*, and they pass through chutes to the workmen on the floor below. The knotting machines, which are fed by the coiling machines, form a line through the center of the shop only a few feet away from the coilers. Approximately one-half the length of the shop is taken up by these two rows of coilers and knotters.

In Fig. 5 are shown the chutes through which the springs come from the knotting machines on the floor above. There are 106 of these chutes; half are on the side here shown, while the remainder are placed to the left, back to back with these chutes. They occupy the center of the shop, lengthwise. An operator sits at the machine in front of each pair of chutes and takes the springs from them to form them into what are called "strips." To make these strips, sheet metal ribbons are bent to a U-shape like those shown at *Q*. One of these is clamped to each side of four springs, and the whole is long enough to give the completely assembled spring its desired width. One strip that has just been formed is shown in the first machine, and others can be seen on the rack and floor. These strips are passed over the rack at *S* to other workers, who assemble them into full-size seat springs. When the strips are made faster than the assembler can handle them, they are stored underneath the rack, as shown at *T*.

Fig. 6 shows the benches where large seat springs for Ford cars are assembled. The assembler starts with a foundation frame like that at *U*, which is in two pieces. These pieces are made by passing band iron or strip steel through rolling machines that form it into a shape similar to channel iron. When these two pieces are riveted together, they form a foundation frame that gives the completed seat spring its size and shape. The first work of the assembler is to fasten the strips, consisting of four springs each, to this frame. First the two end strips are located as shown at *V*, and then the center strips are filled in as illustrated at *W*. After that the wire frame shown hanging on the column at *R*, is clamped to the top of each coil spring around the outside of the assembled seat spring. The ends of this frame are welded together to make it continuous.

The next operation is to fasten all the individual springs to this wire top frame with specially bent wires that pass from side to side of the assembled springs. Next, similar bent wires are run lengthwise of the seat spring and are clamped to both sides of each coil spring, and to the wire frame at both outer ends. The final operation is to clamp the centers of all the coil springs together. To do this, hoop iron or band steel is cut to length and bent into shapes that hook over and are bent around the center coils of the springs that are nearest together. Thus each spring is securely fastened at the top, bottom and center to each spring on its four sides. This keeps them in their correct position. Thus, when one spring is compressed it gets support from all the other springs in the assembled seat; and the more it is compressed the more support it will get. The reason for binding all the individual coils together so firmly is to prevent them from working loose from the hard usage an automobile seat gets when the car is traveling over rough roads. You will know what that means if you have ever taken a ride that bounced you up in the air until your head struck the top, which drove you back into the seat so hard that it flattened every coil spring, to say nothing of your bones.

In Fig. 7 is shown the overhead trolley system that passes over the assembling benches and conveys the seat spring through the japanning department and on to the shipping room. When the springs are assembled, they are hung on hooks suspended from gas pipe carriers, like those shown at *Y*. With bolts *X*, these are hung to four-wheeled roller-bearing trolleys that travel inside the tracks. As will be seen, single-track *Z* passes in front of the chutes and branches curve out from this to run over the assembling benches, with a switch

Fig. 5. Forming Springs into Strips ready for assembling into Frames

Fig. 6. Benches on which Seat Springs for Ford Cars are assembled

Fig. 7. Conveyor System for carrying Springs to Japanning Department

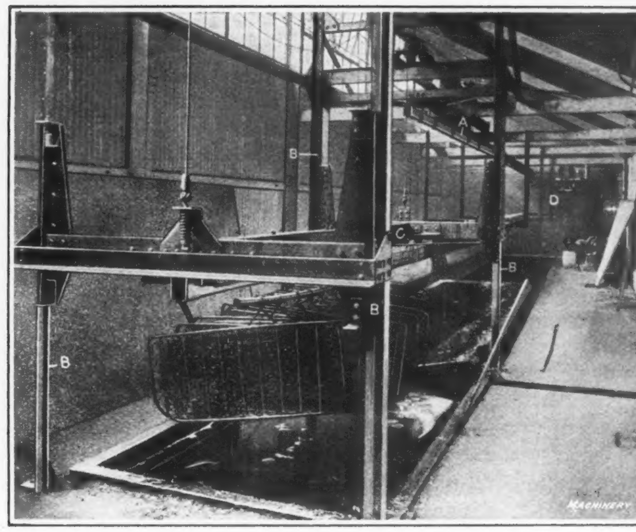

Fig. 8. Arrangement of Japan Dipping Tank for Assembled Springs

at each branch. These branches merge into one track again, next to the wall on the right, and at the far end this curves into the japanning room, which is at the other side of this wall. In front of the chutes will be seen the strip makers and in the center the assemblers.

With the methods of manufacture used in the old shop it took approximately two and one-half men to make as many springs as are made in the new shop by one man. The greatest saving in labor was effected at this point; but the japanning methods, described later, ran a close second, and important improvements in efficiency were made in the back springs department, now located on the third floor of the building. Here one can readily realize the saving in labor by observing how the coilers pass the coiled springs to the knotters; the knotters drop them through a hole in the floor (Fig. 4) into chutes; the strip makers pick them out of these chutes on the floor below, Fig. 5, make them up into strips, and pass them over racks to assemblers; the assemblers complete the seat springs, Fig. 6, and hang them on hooks overhead, while one man pushes the loads into the japanning room.

When the loads of springs enter the japanning room they roll onto a loose piece of track under the hoisting apparatus, which lowers them into the japan dip tank, as shown in Fig. 8. The springs enter the japan room on the track level shown at *A*, and the four posts *B* act as guides for the hoisting apparatus, so that the loose piece of track can be brought into alignment with the two different levels at *A* and *C*. This view shows one load of springs as it is being lowered into the japan. When coated with japan, the load is raised back to one of the two track levels, and the springs travel over a drain board some thirty or forty feet long, where the excess japan flows off. The japan is thinned with naphtha, and if this draining were not done the japan would be likely to catch fire from the heat in the baking oven. After that, the spring loads are rolled into the japan baking oven *D*, shown at the far end of the illustration.

This company had a serious explosion with gas-fired japanning ovens in the old shop, which ripped apart the oven and blew out one side of the shop. Hence, it was decided to use fuel oil for heating the oven in the new shop. Incidentally, the saving in fuel bills is something over $200 per month—with fuel oil at the war price of 5½ cents per gallon. How dangerous the japan baking proposition is, if the work is not drained properly, and the baking done in an oven that is not constructed, fired and vented correctly, is shown by the fact that electric heaters exploded the japan fumes in an electric oven used in Detroit and nearly caused the death of the oven tender, who remained unconscious for two days. It also caused so bad a fire in this works that the management decided to throw out the electric plant and not do any more japanning.

Fig. 9 shows the opposite end of the japan baking oven, where the springs are pulled out and sent into the shipping room. Alleyway *I* is where the oil burners are located for heating the ovens. These burners are of the megaphone type and shoot the flames into 10-inch pipe coils. The spent gases leave these pipe coils through sheet metal pipe *J*, which conveys them to a central stack. It will be seen that four tracks, on two different levels, carry the springs through the oven; and the door of one compartment stands open, ready to pull out the springs. The springs seen in the oven seem to occupy a very small part of the space, but they fill the oven much more completely than this view would indicate, the illusion being due to the fact that the springs were some ten feet back from the door. The two different track levels are shown at *F* and *G*. Two tracks *F* switch into one, and the springs travel

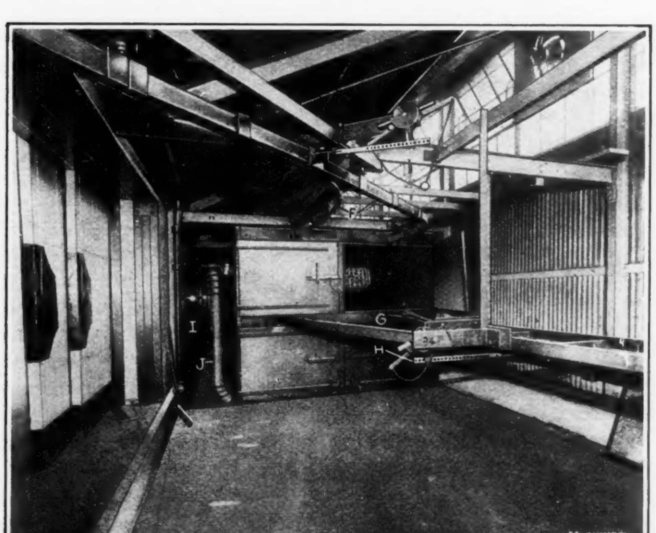

Fig. 9. Delivery Door of Japan Baking Oven and Conveyor leading to Shipping Room

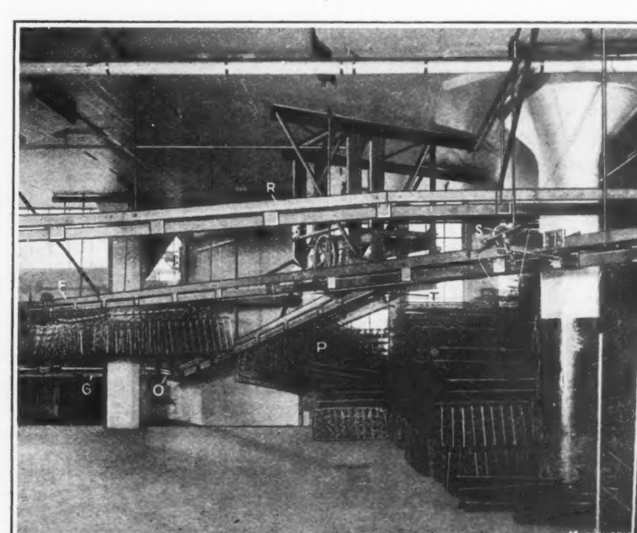

Fig. 10. Means of elevating Springs from Track Level G to Upper Level F

over this directly into the shipping room; tracks *G* are merged into one by switch *H*. This track curves into the shipping room, which is located just to the right of this view. There the work is raised to the track *F* level, and from there on all the work travels over the same tracks.

Most spring makers consider that 450 degrees F. is the best temperature for the japan baking ovens. They claim the work of coiling, knotting, etc., sets up strains in the wire, which this temperature will relieve. While the wire is supposed to be hardened and tempered properly before it leaves the wire manufacturer, they say it must be drawn again at 450 degrees F. to prevent breakage of the springs after they are coiled. This temperature has proved to be the best for drying out the japan and producing a very hard coat. It may be, however, that the japan makers have made their japans fit this temperature on account of the necessity of tempering the steel. However that may be, these two things are accomplished by heating the springs to 450 degrees F. while the japan is being baked.

In Fig. 10 is shown the apparatus that brings the work from lower track level *G* up an incline to the level of track *F*. An electric motor moves a conveyor chain around two sprocket wheels, one of which is shown at *T*. When the load of springs reaches the position marked *O*, the hooks on this conveyor chain grip the load and haul it up the incline, as shown at *P*. At switch *S* the springs from both the upper and lower levels are switched onto one track; and from here onward they are either unloaded to be crated for shipment in freight cars or loaded directly into motor trucks to be carted to various shops in Detroit. The empty spring carriers are then sent over track *R* back to the assemblers, where they are reloaded for another trip. None of this apparatus is very high in first cost or cost of upkeep. Thus one can readily see that such costs are soon paid by the reductions made in the payroll.

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PAROL CONTRACTS IN THE SHOP

BY ERIC LEE[1]

The rapid development of machinery and machine parts, the keen competition of the market, and the scarcity of skilled labor have often brought the management of machine shops face to face with untold difficulties. Oftentimes it is essential that fixtures or jigs be made for certain operations on production work within a time limit. In many shops the work of making such fixtures or jigs is let out to the workman by what is known as simple or parol contracts. Under this system one of the workmen agrees to do the work for a certain sum, and the firm usually agrees to pay him his regular wages and, if the bid is in excess of this amount, the balance of the bid.

The method of putting these contracts into the works is somewhat as follows: Contract sheets and the blueprints of the mechanical device to be made are sent to the shop foreman, who gives them to the workmen whom he thinks can do the work. These study the blueprints, put their bids in sealed envelopes, and return the prints, together with their bids, to the foreman. The bids and blueprints are then sent to the planning office and compared with the estimate which has been made out by the works estimator. If the bids are too high, the blueprints are again sent into the shop and other workmen asked to make bids for the work.

The advantages claimed for this method are: rapid execution of work, decrease in supervision required, and reduced cost of labor. Among the disadvantages are: inferior workmanship, excessive wear of machinery and tools, dissension among workmen, and higher cost of shop production.

In regard to the first advantage claimed, it may be said that while the work is done rapidly, the workmanship is frequently poor. As a result, an unsatisfactory jig or fixture must be used because there is not time to make another. Less supervision is required because a man building a jig or fixture by contract will stick fast to his work, and should he have any men or apprentices working for him, he will so plan the work that the men and boys are not at any time idle. He will see that one piece follows another, and that while some work is in the hardening shop there will be other material to work upon. He will also see that each piece is milled, ground, slotted, drilled or tapped properly; and that the proper screws, studs, dowels, etc., have been assigned to him.

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The cost of labor is frequently decreased because apprentices are called upon to use more of their ability, and work is given to them that would be given to a journeyman if the work were done by the day instead of by contract. Besides, the contractor uses more ingenuity; he tries to devise some way to do this or that operation more quickly. For instance, he thinks out whether he can better rough-mill six pieces at a time with a gang mill or take each piece and finish it separately; he determines whether it would be more profitable to make a temporary jig for certain parts or to lay out each part individually. If a similar jig or fixture had been made before, he will try to remember what work of the other contractor should be copied and what work should be avoided.

The plan has the disadvantage that the work turned out is often of an inferior quality. A man who forms the habit of rushing work gets careless and slovenly, easing his conscience with the expression, "There's nothing particular about that; it will pass inspection all right." To inspect a complicated fixture requires considerable time for taking down and rebuilding. If a fixture is inspected and rejected two or three times, the cost of inspection should be considered dead loss.

Another disadvantage is the excessive wear of machinery and tools. Machinery has come to the scrap pile too soon through machine parts being made by contractors. One contractor, when spoken to about the abuse of a new Brown & Sharpe milling machine, retorted, "What spoils this machine helps to buy another." When busy, the contractor frequently forgets to lubricate the machine until some trouble arises. The cost of machine tools is a considerable item, and with the rush a mill or cutter is easily broken, a splining tool snapped, a drill burnt, or a tap or reamer put out of business. In addition, special cutters are often used, and the cost of making special cutters is well known.

Contracts also cause dissensions among the men. The contractor may tie up a number of the machines to the disadvantage of his fellow workmen. Besides, he may leave the machines dirty, for he can make money on his contract only by getting the work out at an early date.

Contract work increases the shop's production costs, for the contractor on a rush job has the privilege of breaking down the men's work because he needs that lathe or this milling machine, when perhaps it has taken two hours to set the machine up for the day-work job. Then again, the time taken by three or more men estimating upon one contract should be considered, as well as the extra clerical help involved.

All manufacturers are striving for maximum production with minimum cost, and many workmen have the best interest of the employers at heart. Experience, however, teaches that jigs and fixtures cannot be made hastily. One of the safeguards of good work is time, and oftentimes the good results are worth the additional time expended. It is comforting to know that the shop is working in perfect harmony. Each man is only capable of a limited amount of work, and a good foreman knows where that limit lies, and is keenly alive to the urgency of each particular case, so that by proper supervision he can speed up deliveries, unhampered by the trouble of carrying on individual contract work in the shop.

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About the time when the low-priced automobile became so popular that everybody bought at least one, a gentleman down in Alabama who had some capital laid by and nothing of a commercial nature to engage his time and energies decided to re-enter commerce. After casting about for some time, he fixed upon the buggy business as an attractive venture, and accordingly bought an outfit for a buggy factory. A friend across the border, in Tennessee, heard of the new enterprise and was moved to write the proprietor a letter.

"Dear Charley"—he wrote—"I hear you are going to make buggies. I wish you good luck. But I would like to make a suggestion: If the buggy business should grow slack, why not do over your plant and go in for the manufacture of flintlock muskets?"—*Saturday Evening Post.*

NOTES ON THE MACHINERY INDUSTRY IN EUROPE[1]

PROBABLE CONDITIONS OF THE MACHINE TOOL MARKET AFTER THE WAR—RUSSIAN TRADE OPPORTUNITIES

BY ALEXANDER LUCHARS[2]

AMERICAN manufacturers are interested in the uses to which the European machine tool and munition plants will be put after the war. Most of the latter, not especially constructed for munition work, will return to their former products; but some will take up the production of machine tools and supplies, and of course the former will continue in their present lines with extensions, as is the custom with European manufacturers. Their weakness is the lack of specialization, caused by their generally limited markets. The English machine tool manufacturers are wide awake to the fact that they have neglected the European market, and they quote the German export figures of more than $15,000,000 in machine tools in 1913 against their own export figures of $3,750,000. When the war broke out they found that most of the machine tools in their factories were of foreign origin, and they are firmly resolved to change this policy. The production of British machine tools has acquired a strong impetus through the war demands. Manufacturers there have accumulated considerable profits in spite of the heavy taxes, and a fund of practical experience as well, which they will not fail to utilize in producing tools for their own and other European markets.

Besides the productive capacity of the machine tool plants of Great Britain we must also consider those in neutral countries like that at Oerlikon, Switzerland, and of A. S. Nielsen and Winther, Copenhagen, Denmark, said to employ one thousand hands. These and others like them are war developments and will continue in the same line of product. They probably will endeavor also to improve the quality of their product so as to approach that of the best American manufacturers, which is everywhere recognized as the standard. There will be no market in Europe for cheap American machine tools, but there will be for high-grade tools of reputation, such as milling machines, automatics, turret lathes and other highly specialized tools, some of which are not now made in Europe at all, or if they are, not in sufficient quantities to keep the cost low and the quality high. I believe that a home market is necessary to insure the successful manufacture of such products, and the American specialist who can keep his own costs down by producing in large quantities should be able to undersell the manufacturer in a limited market, even if the latter is protected by tariffs and freight charges. This condition can be met and overcome by a continued advance in our manufacturing methods, and by an increase in our ability to give better value in such products than can be obtained in Europe.

Women will continue to be employed in the European machinery industries: first, because their efficiency has been a revelation to employers; second, because they have never yet left an occupation in which they secured a foothold; and third, because many of them will be obliged to support crippled husbands and kinspeople, and the state will not countenance any effort to thrust them out of the shops under such conditions. High prices for all commodities, in my opinion, will continue to prevail; and with the reduced labor supply, wages will not decrease. Unless there is a period of general unemployment they may even go higher. This general increase in costs should bring production costs nearer those of American manufacturers, and with improved methods our manufacturers should be able to compete more nearly on a cost equality with those of Europe.

There is no hostility toward Americans except in Germany and Austria; but the national and industrial policies of Great Britain and her Allies are shaped to confine their purchases of war material and of every other kind to home products whenever possible, for the purpose of reducing their adverse trade balances and to keep the business at home. The Ministry of Munitions is endeavoring to reduce the orders for machinery and material placed in the United States, and when that is not practicable, to reduce the prices being paid. The recent contract clause which provides for cancellation after September 1 is made to provide for control over both. An order recently issued by the same authority requires "the most rigid economy in the use of skilled labor and material, and that no machine tools be purchased for carrying out government contracts unless it is impossible to use existing machines." In certain cases orders that have been placed for tools have lately been cancelled, and the work for which they were intended has been transferred to other firms who have facilities for doing it without purchasing additional equipment. These measures indicate the close, rigid and economical control which is now being exercised by the British government over the purchase of all kinds of war material. The period of waste and enormous profits is past.

This policy, in my opinion, will continue to be enforced by all the European nations, and will affect our exports of machine tools after the war; but we can hardly criticize them when we have made so many millions out of their necessities during the past two years.

It is thought in Great Britain that government control of the railways will be continued after the war, as it has worked out very satisfactorily; but it should be remembered that the British railroads are being run by their former experienced managers, who are working together in friendly cooperation, with all competition and wasteful duplication of service eliminated, and with the help of the government's autocratic power they have accomplished wonders. When these men are replaced with a bunch of politicians, the results may be different, as they were in France before the war.

Russia is now being widely exploited as an unlimited market for American products, and a number of statements have lately been published describing the opportunities for American manufacturers to establish plants in that country. This is doubtless practicable for industries like that of the International Harvester Co. or the Singer Sewing Machine Co., for whose products there is an expanding market; but there is no opening in Russia at present for the manufacture of machine tools and supplies, because the demand is too limited. Russia has vast natural resources, principally agricultural; also great mineral wealth and some manufacturing. Metal manufacturing has been undertaken there only to a limited extent and its growth will be slow, for while Russia will develop greatly after the war, if no revolution intervenes, its expansion will be along lines that will not immediately benefit our manufacturers of machine tools. Russia will buy from Germany very soon after the war closes. The feeling between them is less bitter than between any other two "enemy" countries. Germany makes many cheap products that Russia needs and cannot get elsewhere at as low prices and in the forms desired, and Germany pursues a commercial policy of granting long-time payments instead of demanding cash, as our manufacturers must until banking connections are much better than at present. Thousands of Germans have married in Russia, and there are many influential native Russians with German names and affiliations, so that while the German influence will probably not predominate as before the war, it will continue to be powerful, socially and politically, and will be exerted to help Germany commercially.

Americans are more popular in France than elsewhere in Europe, because they have been permitted to take a more active part in the war relief work there than in any other country. There are any number of American hospitals in France sustained by American money and operated by American workers; and as everyone knows, there are thousands of Americans actively employed, not only in war relief work, but in the French army. This and other well known causes have embittered the Germans against America, and we shall have difficulty in re-establishing our commercial relations with

[1] For previous articles on the conditions of manufacturing and the machine tool trade in Europe, see the September and October numbers.
[2] Publisher of MACHINERY.

Germany. The antagonism in that country against the different nations may be rated about as follows: (1) British, (2) American, (3) Japanese, (4) French, (5) Russian. As the European demand for machine tools has been confined to those used for munition work, it was rather difficult to get information about new machines which might be profitably exported from this country. There seems to be a market for relieving lathes, for tool grinders known in England as the Lumsden pattern (which are of a somewhat similar type to those made by Gisholt and Sellers for grinding lathe and planer tools), for "capstan" attachments for engine lathes, and for spur gear grinders.

There are numerous cases where machine tools employed on munition work have been worn out or broken up by bad usage, but I think that is the exception rather than the rule, and that the percentage of such machines will not be large. The amount of machine tools necessary to re-equip plants that have been destroyed or stripped by the Germans is difficult to estimate. On the Eastern front the amount will be small, because there are few machine shops there; in Belgium, if reports are correct, it will be quite large. How many will be replaced from equipment that will pass out of use when the war ceases is a question. If the present British policy in regard to the purchase of machines is carried out generally, none will be bought that can be replaced from "stock." The French and British governments are working in close cooperation on all such details. A considerable portion of the losses in the fighting area of France, outside of large cities, will be confined to building material and household furniture; and the reconstruction, for a time at least, will be of inexpensive character, similar to the buildings now being shown in the Tuileries Gardens on the Place de la Concorde in Paris. The number of machine tools required in the cities in that part of France will be considerable, but hardly sufficient to greatly increase the exports from this country in view of the possible way in which accumulated material will be handled.

It is almost as difficult to answer the inquiry as to our moral and business standing with European countries as to say when the war will end. The reputation of our well known, reliable manufacturers is just as high as ever; but some newcomers in the machine tool field, and others who should know better, have injured the American reputation by failing to keep their promises and by delivering machines which should never have left their shops—with all due allowance for labor and material troubles here. It surely pays in the long run to so deal with a customer that he will wish to continue the business relation; but some of our manufacturers have not followed that policy.

* * *

From time immemorial, manuscripts, plans and drawings have been rolled or folded with the back or blank side out. The reason, of course, is that it seems desirable to cover the face of a drawing and protect it from injury. The disadvantage of the practice is that a drawing rolled with the face inside is difficult to straighten out and use. It will curl up when lying on a table for a long time after being released. It was pointed out some years ago that it is better practice to roll drawings with the face out. Then when they are released and laid on the table face up the tendency to curl lifts the center rather than the edges. The result is that the drawing soon straightens out and lies flat. In view of this, it was suggested that the practice of publishers of magazines be changed so that the magazine be rolled or folded for mailing with the front cover page out. MACHINERY was one of the first publications to adopt the plan, and now the practice is becoming general. Many of the large publications, such as the *Saturday Evening Post*, the *Ladies' Home Journal*, etc., are rolled with the front cover out. A magazine so rolled may be laid on the table after removing the wrapper and in a few hours it straightens out and lies flat. Of course the same action would take place if rolled the other way, provided the magazine was laid down with the back cover up, but the universal tendency of everyone after tearing off the wrapper of a magazine is to lay it down with the front cover up. By simply reversing the process of rolling, the general practice is made to counteract automatically the defect caused by rolling or folding.

CASTING AND MACHINING MALLEABLE IRON PARTS

BY H. W. JOHNSON[1]

Malleable iron is a material with which all experienced mechanics have had to work, although shops engaged in the manufacture of pipe fittings, agricultural implements and hardware are probably the largest users. The production of small hardware parts and pipe fittings presents some of the most intricate problems which the foundry encounters; but such parts are comparatively easy to handle in the machine shop, owing to their small, compact form, which does away with trouble from distortion. Large quantities of thin, crooked malleable iron parts are used in the construction of all classes of agricultural implements, but more particularly on harvesting machinery; these parts have numerous lugs and bolting surfaces, none of which are machined, but which are required to bear a definite relation to each other and to certain holes drilled in the work. From the standpoint of production cost, it is desirable to drill out cored holes rather than to drill from the solid, and this still further complicates the problem, as the cored holes have to be brought into the proper relation to each other in order that they may "clean up" properly when drilled.

Among the difficulties commonly met with in the production of malleable iron parts, the following are worthy of special attention: (1) Variations in thickness due to poor or irregular ramming, excessive rapping or careless pouring of the metal. (2) Variations in length due to excessive rapping or unequal shrinkage. (3) Warping due to uneven shrinkage in

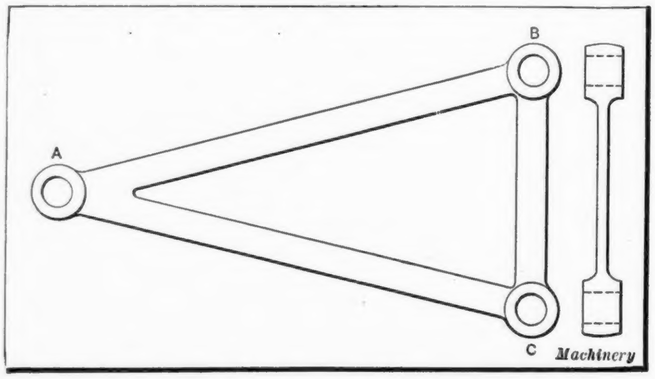

Fig. 1. Malleable Iron Casting with Three Cored Holes to be bored

the original hard iron casting or to poor packing in the boxes in which the heat-treatment is conducted. Variations in thickness are usually such that they can only be corrected by machining, the cost of which, in most cases, would be prohibitive. Occasionally, however, a casting can be hammered down at the working point by means of an operation performed under the drop-hammer with a die made to concentrate the effect of the blow at the important points on the work. A case in point is the knife head of a mowing machine, in which the knife is guided by a flange about 1/2 inch wide by 1/4 inch thick and 4 or 5 inches long. This flange runs in a groove and must not be too thick. Where trouble is experienced with the casting, the steel die used on the drop-hammer sizes the head casting very nicely.

When castings are too thick to allow of the performance of the sizing operation of the kind referred to, trouble due to lack of uniformity in size can often be avoided by selecting the proper locating points when designing jigs or fixtures, if room has been provided for the excess stock to overhang where it will do no harm. The mowing machine knife head will serve as a further example to illustrate this point. In sizing the work to correct an error in thickness, the width must be neglected. In this piece a row of rivet holes is drilled to rivet the head to the knife, the work being located in the jig from the rear or guiding edge, so that the excess width overhangs on the front, where ample clearance has been provided. This point is one that must be carefully watched by every designer if he expects to secure uniformly

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satisfactory results in designing parts for which malleable iron castings are used.

Variations in length can sometimes be corrected if the casting has a curved section, into which excess stock can be forced or from which a small "draw" can be obtained without interfering with the usefulness of the casting. This is done by means of dies which will be described in a subsequent paragraph. A triangular casting with a cored hole in each corner, as shown in Fig. 1, would be hopeless if the cored holes had to be bored out clean with a definite distance between centers; but by changing the design to the form shown in Fig. 2, any ordinary error could be corrected by an operation performed under the drop-hammer. If such a change is not allowable, the only alternative would be to dispense with the cored hole in boss *A* and elongate the boss to provide the required compensation for variation in length; the hole would then be drilled from the solid metal to give the required distance between centers. The cost of production would be greatly increased by such a practice, because a twist drill running in solid metal cannot be depended upon to cut to size, while a three-lipped drill working in a cored hole will do uniformly good work. In other words, the drilling of holes from the solid would cost more in itself, and it would also be necessary to ream them in order to insure accuracy of size.

All ordinary errors due to warping can usually be corrected by "dropping" the malleable iron castings in cast-iron dies. If it is only necessary to bring the casting back to form in one plane the problem is a simple one, as a pair of dies parted on the horizontal center line of the casting will give the desired result. Should it happen that the casting requires considerable correction in a sidewise direction, as well as up and down, the dies will have to be made in such a way that the lower die is provided with a substantial wall which is a close fit around the important points on the work, but cut away to provide clearance for gates, etc. The upper die should come down inside without touching this wall, and provide pressure to give the desired form to the work. Such a die is well suited to the requirements of forming a piece of work of the kind shown in Fig 2, and it will not only form the castings, but will also correct errors in length and width.

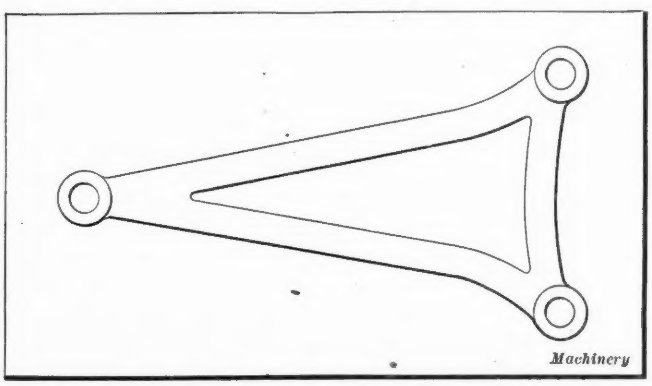

Fig. 2. Casting to replace the One shown in Fig. 1, with Curved Arms to compensate for Errors in Center Distance

In designing a lower die for sizing a piece of this kind, the bosses on the work should be made to fit snugly in the pockets in the die, but the webs should receive only a flat blow, the dies being designed to allow them to give in a sidewise direction to compensate for correction which must be made in the length and width of the work. If the bosses are longer on one side than on the other, the longest side should be placed underneath, because driving the bosses down into the pockets in the lower die results in providing the necessary correction in center distance. The bosses must be given plenty of side clearance in the top die to allow for the usual looseness of the head in the average drop-hammer found in malleable iron foundries, otherwise they are likely to be badly dented at the corners.

The angle at which the work is struck is a very important matter, and the patternmaker who makes the patterns for the die will have to turn his sample piece until he has found a position in which all important points will be adequately supported by the bottom die, and at the same time receive a fair blow from the top die. If one side of the casting is much stiffer than the other, the stiffer side should be placed in such a position that it will receive the heaviest part of the blow. Some pieces of work have so much spring that treatment under the drop-hammer has relatively little effect on them, and the best that can be done with such pieces is to use a heavy hammer with a relatively low lift, so that a slow, "soggy" blow is delivered without any rebound. Heating the work before hammering will help to make the blow of the hammer effective, but this is likely to damage the metal.

In machining malleable iron castings, the use of plenty of cutting compound is of the utmost importance, as a copious flow should be delivered to the work at all times. In drilling holes in solid metal, a moderate feed should be used with all the speed that the drill will stand; and for drilling cored holes with a three-lipped drill a cutting speed of about 65 feet per minute with a feed of from 0.030 to 0.065 inch per revolution will be found to give satisfactory results. In reaming holes, the best results will be obtained with a speed of about 30 feet per minute and the heaviest feed that can be employed. When facing operations are performed with sweep cutters, a flat blade should be used, which is set at an angle of 15 degrees top rake and a little ahead of the center to afford a shearing action. With plenty of lubricant, such a cutter will work rapidly and produce a good finish. For hollow-milling, the cutter requires a top rake of 8 degrees and a clearance of 3 degrees, with the teeth cut far enough ahead of the center to provide a free curling chip. Tapping and threading operations may be satisfactorily performed in malleable iron if plenty of lubricant is used; holes to be tapped should be slightly larger than in the case of steel, as the tool will produce a good full thread under such conditions.

In general, it will be found that malleable iron will hug the tool closely and finish to practically the size of the tool if plenty of lubricant is used; but if it is attempted to run the tools dry, their action is likely to be erratic, one hole coming large, the next small, and *vice versa.* Jigs and fixtures must afford support close to the cutting tools, owing to the springy nature of the iron; and facing and counterboring tools ought to be equipped with roller pilots to avoid scoring the bored holes in which they run. Cored holes can be drilled with three-lipped spiral drills within a limit of ± 0.002 inch, using feeds and speeds which afford a high rate of production. The drill should be one-third of the total tolerance larger than the small limit allowed on the work; for instance, to drill a 7/8-inch hole on which the limits are 0.875 and 0.879 inch, the drill would be made 0.8763 inch.

* * *

S. A. E. STANDARDIZES AUTOMOBILE NAMES

The Society of Automobile Engineers has sent out the results of six months standardization work, which has for its purpose the establishment of precise and expressive terms for motor car parts and accessories. There are many advantages in having uniform names of car parts. The motor car user would find it much easier to make replacements if there were general agreement as to the use and meaning of terms. The manufacturer would benefit for the same reason and the entire industry would welcome a list of names that will remedy the present chaotic condition in which each maker seemingly uses a different terminology.

The list of names recommended by the Society of Automobile Engineers was developed through the combined efforts of engineering and service representatives of a number of leading motor car manufacturers. Over six hundred separate names of the more important parts are given. No attempt was made to list minor parts, the names of which are well understood. Definitions are included for axles, brakes and bodies for which uses vary. The names of bodies particularly are in need of standardization because of the wide variety of names used by different makers. The term "engine" is recommended rather than "motor" to avoid confusion with electric motors used for starting the engines installed on cars.

RULES FOR CRANE OPERATION

Traveling cranes are an indispensable feature of modern plants. Their capacity for lifting and conveying parts and materials is practically unlimited, but unfortunately their operation is attended by many dangers. Crane men and chain men become careless, and green men on the floor are likely to give wrong signals or signals that may be misunderstood. F. B. Prescott of the Boston & Montana Reduction Works recommends in the *Anode* the following:

1. That there be established through the safety bureau uniform traveling crane signals to come into effect in all industrial establishments.[*]
2. That men be appointed crane chasers who are well informed on such signals.
3. That every man aspiring to the position of either traveling crane operator or signal man shall pass an examination in signaling among the other requisites for his office.

Mr. Prescott points to the uniform signals used by shifting crews on railways the country over, and states that uniformity is equally desirable in the operation of traveling cranes. All railways put their engineers and firemen through official examination, and these men are not generally better paid than crane operators. The number of traveling cranes in use and men operating and attending them makes the subject of general importance in the industrial world. The recommendation in regard to the operation of cranes and the establishment of a uniform code of signals should meet with general approval by industrial works managers generally.

* * *

The oxide on high-speed steel melts at a temperature of about 1250 degrees C. (2300 degrees F.) which is the approximate temperature for hardening. A skilled hardener can observe the oxide melting and thus determine with fair accuracy the proper hardening heat.

CHANGE-GEAR TABLES FOR SCREW CUTTING

BY MARTIN H. BALL[1]

In December, 1910, I contributed an article to MACHINERY dealing with the subject of cutting fractional screw threads, and giving tables of the different available ratios for change-gears furnished with lathes having lead-screws with four, five and six threads per inch. These tables made it easy to determine the ratio of different combinations of gears without taking the time to make calculations, but in the present article the process has been carried a step further. In this case the arrangement of the tables is the same except that the pitch of the lead-screw has been taken into consideration, so that the number which appears at the intersection of vertical and horizontal lines through any two gears represents the pitch of the screw that will be obtained by using those two gears on the lead-screw and spindle of the lathe.

To illustrate the use of these tables, we will assume that it is required to cut a worm to drive a worm-wheel having teeth of 10 diametral pitch. Referring to Table IV, which gives the relation between the diametral pitch of worm-wheels and the corresponding pitch of worms which mesh with them, we find the pitch of a worm to mesh with a worm-wheel of 10 diametral pitch is 0.314 inch. Next referring to Table III, which gives the pitches obtainable with change-gears on a lathe with a lead-screw having five threads per inch, we find that the use of a 55-tooth gear on the spindle and a 35-tooth gear on the lead-screw provide for cutting a screw with a lead of 0.3142 inch. The error resulting through the use of this gear combination is only 0.0002 inch, which is not great enough to give any trouble except in cases where great accuracy is necessary.

As a further example of the use of the tables, suppose that a

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TABLE I. PITCHES OBTAINED USING LEAD-SCREW WITH THREE THREADS PER INCH

Number of Teeth in Lead-screw Gear	Number of Teeth in Spindle Gear																
	21	24	26	28	30	32	36	40	48	56	64	72	88	92	96	104	112
21	......	0.3809	0.4126	0.4444	0.4761	0.5079	0.5714	0.6349	0.7619	0.8888	1.0158	1.1428	1.3968	1.460	1.5238	1.6504	1.7777
24	0.2916	......	0.3611	0.3888	0.4166	0.4444	0.500	0.5555	0.6666	0.7777	0.8888	1.000	1.2222	1.2777	1.3333	1.4444	1.5555
26	0.2692	0.3076	......	0.3589	0.3846	0.4102	0.4615	0.5128	0.6153	0.7179	0.8205	0.9230	1.1282	1.1794	1.2307	1.3333	1.4358
28	0.250	0.2857	0.3095	......	0.3571	0.3809	0.4285	0.4761	0.5714	0.6666	0.7619	0.8571	1.0476	1.0952	1.1428	1.2380	1.3333
30	0.2333	0.2666	0.2888	0.3111	......	0.3555	0.400	0.4444	0.5333	0.6222	0.7111	0.800	0.9777	1.0222	1.0666	1.1555	1.2444
32	0.2187	0.250	0.2708	0.2916	0.3125	......	0.375	0.4166	0.500	0.5833	0.6666	0.750	0.9166	0.9583	1.000	1.0833	1.1666
36	0.1944	0.2222	0.2407	0.2592	0.2777	0.2962	......	0.3703	0.4444	0.5185	0.5925	0.6666	0.8147	0.8518	0.8888	0.9629	1.0370
40	0.175	0.200	0.2166	0.2333	0.250	0.2666	0.300	......	0.400	0.4666	0.5333	0.600	0.7325	0.7666	0.800	0.8666	0.9333
48	0.1458	0.1666	0.1805	0.1944	0.2083	0.2222	0.250	0.2777	......	0.3888	0.4444	0.500	0.6111	0.6388	0.6666	0.7222	0.7777
56	0.125	0.1428	0.1547	0.1666	0.1785	0.1904	0.2142	0.2380	0.2857	......	0.3809	0.4285	0.5232	0.5476	0.5714	0.6190	0.6666
64	0.1093	0.125	0.1354	0.1458	0.1562	0.1666	0.1875	0.2083	0.250	0.2916	......	0.375	0.4583	0.4791	0.500	0.5416	0.5883
72	0.0972	0.1111	0.1203	0.1296	0.1388	0.1481	0.1666	0.1851	0.2222	0.2592	0.2962	......	0.4069	0.4259	0.4444	0.4814	0.5185
88	0.0795	0.0909	0.0984	0.1060	0.1136	0.1212	0.1363	0.1515	0.1818	0.2121	0.2424	0.2727	......	0.3484	0.3636	0.3939	0.4242
92	0.0760	0.0869	0.0942	0.1014	0.1086	0.1158	0.1304	0.1449	0.1739	0.2028	0.2318	0.2608	0.3188	......	0.3478	0.3768	0.4057
96	0.0730	0.0833	0.0902	0.0972	0.1041	0.1111	0.125	0.1388	0.1666	0.1944	0.2222	0.250	0.3052	0.3194	......	0.3611	0.3888
104	0.0673	0.0769	0.0833	0.0897	0.0961	0.1025	0.1153	0.1282	0.1538	0.1794	0.2051	0.2307	0.2820	0.2948	0.3076	......	0.3589
112	0.0625	0.0714	0.0773	0.0833	0.0892	0.0952	0.1071	0.1190	0.1428	0.1666	0.1904	0.2142	0.2619	0.2738	0.2857	0.3094	......

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TABLE II. PITCHES OBTAINED USING LEAD-SCREW WITH FOUR THREADS PER INCH

Number of Teeth in Lead-screw Gear	Number of Teeth in Spindle Gear									
	24	28	32	36	40	42	44	48	52	56
24	......	0.2916	0.3333	0.375	0.4166	0.4375	0.4583	0.500	0.5416	0.5833
28	0.2142	......	0.2857	0.3214	0.3571	0.375	0.3928	0.4285	0.4642	0.500
32	0.1875	0.2187	......	0.2812	0.3125	0.3281	0.3437	0.375	0.4062	0.4375
36	0.1666	0.1944	0.2222	......	0.2777	0.2916	0.3055	0.3333	0.3610	0.3888
40	0.150	0.175	0.200	0.225	......	0.2625	0.275	0.300	0.325	0.350
42	0.1428	0.1666	0.1904	0.2142	0.2380	......	0.2619	0.2857	0.3095	0.3333
44	0.1359	0.1590	0.1818	0.2045	0.2272	0.2386	......	0.2727	0.2954	0.3181
48	0.125	0.1458	0.1666	0.1875	0.2083	0.2187	0.2291	......	0.2708	0.2916
52	0.1153	0.1346	0.1538	0.1730	0.1923	0.2019	0.2115	0.2307	......	0.2692
56	0.1071	0.125	0.1428	0.1607	0.1785	0.1875	0.1964	0.2142	0.2321	......
60	0.100	0.1166	0.1333	0.150	0.1666	0.175	0.1833	0.200	0.2162	0.2333
64	0.0937	0.1093	0.125	0.1406	0.1562	0.1640	0.1718	0.1874	0.2031	0.2187
68	0.0882	0.1029	0.1176	0.1323	0.1470	0.1544	0.1617	0.1764	0.1911	0.2058
72	0.0833	0.0972	0.1111	0.125	0.1388	0.1458	0.1527	0.1666	0.1805	0.1944
80	0.075	0.0875	0.100	0.1125	0.125	0.1312	0.1375	0.150	0.1625	0.175
88	0.0681	0.0795	0.0909	0.1022	0.1136	0.1192	0.125	0.1363	0.1477	0.1590
92	0.0652	0.0760	0.0869	0.0977	0.1086	0.1141	0.1195	0.1304	0.1413	0.1521
96	0.0625	0.0729	0.0833	0.0937	0.1041	0.1094	0.1145	0.125	0.1354	0.1458
104	0.0576	0.0673	0.0769	0.0865	0.0961	0.1009	0.1057	0.1153	0.125	0.1346
105	0.0571	0.0666	0.0761	0.0857	0.0952	0.100	0.1047	0.1142	0.1238	0.1333
112	0.0535	0.0625	0.0714	0.0803	0.0892	0.0937	0.0982	0.1071	0.1160	0.125

Number of Teeth in Lead-screw Gear	Number of Teeth in Spindle Gear										
	60	64	68	72	80	88	92	96	104	105	112
24	0.625	0.6666	0.7083	0.750	0.8333	0.9166	0.9583	1.0000	1.0833	1.0937	1.1666
28	0.5357	0.5714	0.6071	0.6428	0.7142	0.7857	0.8214	0.8571	0.9285	0.9375	1.000
32	0.4687	0.500	0.5312	0.5625	0.625	0.6875	0.7187	0.750	0.8125	0.8203	0.875
36	0.4166	0.4444	0.4722	0.500	0.5555	0.6111	0.6388	0.6666	0.7222	0.7277	0.7777
40	0.375	0.400	0.425	0.450	0.500	0.550	0.575	0.600	0.650	0.6562	0.700
42	0.3571	0.3809	0.4047	0.4285	0.4761	0.5239	0.5476	0.5714	0.6190	0.625	0.6666
44	0.3409	0.3636	0.3863	0.4090	0.4545	0.500	0.5227	0.5454	0.5909	0.5965	0.6363
48	0.3125	0.3333	0.3540	0.375	0.4166	0.4583	0.4791	0.500	0.5416	0.5468	0.5833
52	0.2884	0.3076	0.3269	0.3461	0.3846	0.4230	0.4423	0.4615	0.500	0.5048	0.5384
56	0.2678	0.2857	0.3035	0.3214	0.3571	0.3928	0.4107	0.4285	0.4642	0.4687	0.500
60	......	0.2666	0.2833	0.300	0.3333	0.3666	0.3833	0.400	0.4333	0.4375	0.4666
64	0.2343	......	0.2656	0.2812	0.3125	0.3437	0.3593	0.375	0.4062	0.4101	0.4375
68	0.2205	0.2352	......	0.2647	0.2941	0.3235	0.3382	0.3522	0.3823	0.3860	0.4117
72	0.2083	0.2222	0.2361	......	0.2777	0.3055	0.3194	0.3333	0.3611	0.3645	0.3888
80	0.1875	0.200	0.2125	0.225	......	0.275	0.2875	0.300	0.325	0.3281	0.350
88	0.1704	0.1818	0.1931	0.2045	0.2272	......	0.2613	0.2727	0.2954	0.2982	0.3181
92	0.1630	0.1739	0.1847	0.1956	0.2173	0.2391	......	0.2608	0.2826	0.2853	0.3043
96	0.1562	0.1666	0.1770	0.1875	0.2083	0.2291	0.2395	......	0.2708	0.2734	0.2916
104	0.1442	0.1538	0.1634	0.1730	0.1923	0.2115	0.2211	0.2307	......	0.2524	0.2692
105	0.1428	0.1523	0.1619	0.1714	0.1904	0.2095	0.2190	0.2285	0.2476	......	0.2666
112	0.1339	0.1428	0.1517	0.1607	0.1785	0.1964	0.2053	0.2142	0.2321	0.2343	......

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lathe were available which had a lead-screw with three threads per inch and that the work to be done consisted of cutting the threads of a worm with a lead of 0.524 inch to mesh with a worm-wheel having teeth of 6 diametral pitch. This work could be done by using an 88-tooth gear on the spindle and a 112-tooth gear on the lead-screw, with compound gears introduced between them having a ratio of 2 to 1. It will be evident that the ratio 0.262 found in Table I is equal to the result obtained by dividing the desired ratio of 0.524 by 2; hence, it is necessary to compound the gears on the lead-screw and spindle with gears having a ratio of 2 to 1. Similarly, the ratio of the gears compounded with gears on the lead-screw and spindle may be reversed in order to get a thread of finer lead. Gears of other ratios may be compounded into the train, but the use of such gears is not as simple, and should be avoided wherever possible. The gears shown in Tables I, II and III are those most commonly found on lathes fitted with lead-screws having three, four and five threads per inch.

TABLE III. PITCHES OBTAINED USING LEAD-SCREW WITH FIVE THREADS PER INCH

Number of Teeth in Lead-screw Gear	Number of Teeth in Spindle Gear																
	20	25	30	35	40	45	46	50	55	60	65	70	75	80	90	100	110
20	......	0.250	0.300	0.350	0.400	0.450	0.460	0.500	0.550	0.600	0.650	0.700	0.750	0.800	0.900	1.000	1.100
25	0.160	......	0.240	0.280	0.320	0.360	0.368	0.400	0.440	0.480	0.520	0.560	0.600	0.640	0.720	0.800	0.880
30	0.133	0.1666	......	0.2333	0.2666	0.300	0.3066	0.3333	0.3666	0.400	0.4333	0.4666	0.500	0.5333	0.600	0.6666	0.7333
35	0.1142	0.1428	0.1714	......	0.2285	0.2571	0.2628	0.2857	0.3142	0.3428	0.3714	0.400	0.4285	0.4571	0.5142	0.5714	0.6285
40	0.1000	0.1250	0.1500	0.175	......	0.225	0.230	0.250	0.275	0.300	0.325	0.350	0.375	0.400	0.450	0.500	0.550
45	0.0888	0.1111	0.1333	0.1555	0.1777	......	0.2044	0.2222	0.2444	0.2666	0.2888	0.3111	0.3333	0.3555	0.400	0.4444	0.4888
46	0.0869	0.1087	0.1304	0.1521	0.1739	0.1956	......	0.2173	0.2172	0.2608	0.2826	0.3043	0.326	0.3480	0.3913	0.4347	0.4782
50	0.080	0.100	0.120	0.140	0.160	0.180	0.184	......	0.220	0.240	0.260	0.280	0.300	0.320	0.360	0.400	0.440
55	0.0727	0.0909	0.109	0.1272	0.1454	0.1636	0.1672	0.1818	......	0.2181	0.2363	0.2545	0.2727	0.2909	0.3272	0.3636	0.400
60	0.0666	0.0833	0.100	0.1166	0.1333	0.150	0.1533	0.1666	0.1833	......	0.2166	0.2333	0.250	0.2666	0.300	0.3333	0.3666
65	0.0615	0.0769	0.0923	0.1076	0.123	0.1384	0.1415	0.1538	0.1692	0.1846	......	0.2153	0.2307	0.2461	0.2769	0.3076	0.3384
70	0.0571	0.0714	0.0857	0.100	0.1142	0.1285	0.1314	0.1428	0.1571	0.1714	0.1857	......	0.2142	0.2285	0.2571	0.2857	0.3142
75	0.0533	0.0666	0.080	0.0933	0.1066	0.120	0.1226	0.1333	0.1466	0.160	0.1733	0.1866	......	0.2133	0.240	0.2666	0.2933
80	0.050	0.0625	0.075	0.0875	0.100	0.1125	0.115	0.125	0.1375	0.150	0.1625	0.175	0.1875	......	0.225	0.250	0.275
90	0.0444	0.0555	0 666	0.0777	0.0888	0.100	0.1022	0.1111	0.1222	0.1333	0.1444	0.1555	0.1666	0.1777	......	0.2222	0.2444
100	0.040	0.050	0.060	0.070	0.080	0.090	0.092	0.100	0.110	0.120	0.130	0.140	0.150	0.160	0.180	......	0.220
110	0.0363	0.0454	0.0545	0.0636	0.0727	0.0818	0.0836	0.0909	0.100	0.1099	0.1181	0.1272	0.1363	0.1454	0.1636	0.1818	......

Machinery

* * *

POLISHING WHEEL SPEEDS

The nature of the work to be polished determines to some degree the proper speed of the polishing wheels. But for ordinary operations, it is the practice to run at a peripheral speed of about 7500 feet per minute. If the speed of the wheel is too low, the work tends to tear the polishing material from the wheel, and consequently the work suffers in quality and the wheel has to be set up oftener. But if the diameter of the wheel and the dimensions of the work are small, good results can be obtained with lower wheel speed. Loose muslin wheels used for buffing are operated at peripheral speeds of from 8000 to 10,500 feet per minute.—*Grits and Grinds.*

TABLE IV. THREADS PER INCH AND PITCH IN INCHES; DIAMETRAL PITCH OF WORM-WHEEL AND PITCH OF WORM IN INCHES

Threads per Inch	Pitch in Inches	Diametral Pitch of Worm-wheel	Pitch of Worm in Inches	Threads per Inch	Pitch in Inches	Diametral Pitch of Worm-wheel	Pitch of Worm in Inches
2	0.500	1 1/4	2.5133	20	0.050	12	0.262
3	0.333 1/3	1 1/2	2.0944	22	0.045 5/11	14	0.224
4	0.250	1 3/4	1.7952	24	0.041 2/3	16	0.196
5	0.200	2	1.571	26	0.038 6/13	18	0.175
6	0.166 2/3	2 1/4	1.396	27	0.037 1/27	20	0.157
7	0.142 6/7	2 1/2	1.257	28	0.035 6/7	22	0.143
8	0.125	2 3/4	1.142	30	0.033 1/3	24	0.131
9	0.111 1/9	3	1.047	32	0.031 1/4	26	0.121
10	0.100	3 1/2	0.898	34	0.029 7/17	28	0.112
11	0.090 10/11	4	0.785	36	0.027 7/9	30	0.105
11 1/2	0.086 22/23	5	0.628	38	0.026 6/19	32	0.098
12	0.083 1/3	6	0.524	40	0.025	36	0.087
13	0.076 12/13	7	0.449	42	0.023 1/3	40	0.079
14	0.071 3/7	8	0.393	44	0.022 8/11	48	0.065
15	0.066 2/3	9	0.349	48	0.020 5/6	..	....
16	0.0625	10	0.314	50	0.020	..	....
18	0.055 5/9	11	0.286	..	.....	..	....
				..	....	..	

Machinery

METHODS OF HEAT-TREATING MACHINERY STEEL GAGES

In manufacturing solid gages of the plug or ring variety, most gage-makers experience difficulty in overcoming warpage of the material. Machinery steel generally comes out of the fire after carburizing considerably distorted and shrunk, and in order to prevent this manufacturers have endeavored to treat it in various ways. One method is to anneal it previous to machining. This has been tried with more or less satisfactory results, but it does not entirely eliminate the possibility of the gage shrinking during the quenching operation.

A prominent manufacturer of gages employs the following method of heat-treating machinery steel gages: First they are rough-machined all over to within approximately one-sixteenth inch of the finished size. Then they are heated in an ordinary muffle furnace to 1400 degrees F., and quenched in oil, the same as in hardening tool steel. Owing to the low carbon content of open-hearth steel—between 0.15 and 0.20 per cent—the steel does not harden sufficiently to prevent free cutting. After quenching in oil, the gages are allowed to cool off. Then they are finish-machined all over to within the desired limit and packed in bone dust for pack-hardening. The box in which the gages are packed is then placed in the furnace, heated to a temperature of 1500 degrees F., and allowed to remain for not less than an hour, the exact time depending on the depth of penetration desired. After the box has been in the furnace for the correct length of time, it is removed, and the gages are quenched in oil, cleaned off and ground to the finished size. This method has proved satisfactory, resulting in practically no losses from shrinkage; the gages can be machined to within very close limits of the finished dimensions, and then pack-hardened without danger of warping beyond the amount left for finish-machining. In several gages that were carefully measured after carburizing it was found that they had not shrunk 0.0001 inch.

It is general practice to make large cylindrical plug or thread gages from rings and mount them on a hollow handle in order to lighten the weight. In making thread gages of this type, trouble has been experienced in preventing warpage of the rings, and owing to the time required to lap down large plug gages, these are generally machined within close limits of the finished diameter, from 0.0005 to 0.002 inch being left for lapping. Where this small amount had been left for lapping, the ring shrunk in some cases so that the gage would not clean up, and in order to avoid this trouble, the following method was tried: After the gage had been finish-machined, the hole was fitted with a cast-iron plug which was made a fairly good drive fit. The gage with the plug inserted was packed in bone dust, heated to 1500 degrees F., and quenched in oil. A gage carburized in this manner did not shrink 0.0001 inch, which is quite remarkable, considering the usual shrinkage of machinery steel.

MAKING LIMIT GAGES

BY F. B. JACOBS[1]

Limit gages must be classed as essential to the modern manufacturing plant, for without them it would be impossible to maintain a satisfactory working standard and at the same time allow a slight variation from the specified size, thus saving many pieces that otherwise would go to the scrap heap or back to the production department to be refinished. There are many varieties of gages, ranging from the expensive and intricate ones used in rifle and sewing machine manufacture to the rough templets found in the boiler shop. The object of this article, however, is to describe some of the efficient, economically constructed limit gages that are used in the production of automobile parts.

Perhaps the most important factor toward rapid production of the work in question is the setting of limits between which the dimensions may vary, it being obvious that if an attempt should be made to hold every dimension within 0.0001 inch of standard size, the production would suffer. A manufacturer who had adopted this practice would build one car while his more practical competitors would produce a number of cars in the same amount of time. Thus, where efficient production is imperative, the limits should be as liberal as possible — otherwise valuable time is wasted, not only in the production department, but through attempting to keep several thousand special tools up to an unnecessary degree of accuracy. On the other hand, the limits must not be too liberal; otherwise the completed cars, after being put in service, would soon sound more like agricultural machinery than automobiles. The limits should be established by a committee composed of the chief engineer, the chief draftsman, the shop superintendent, the production engineer and the foreman toolmaker. By this method every important point that might affect production, or result in unsatisfactory work, will be considered.

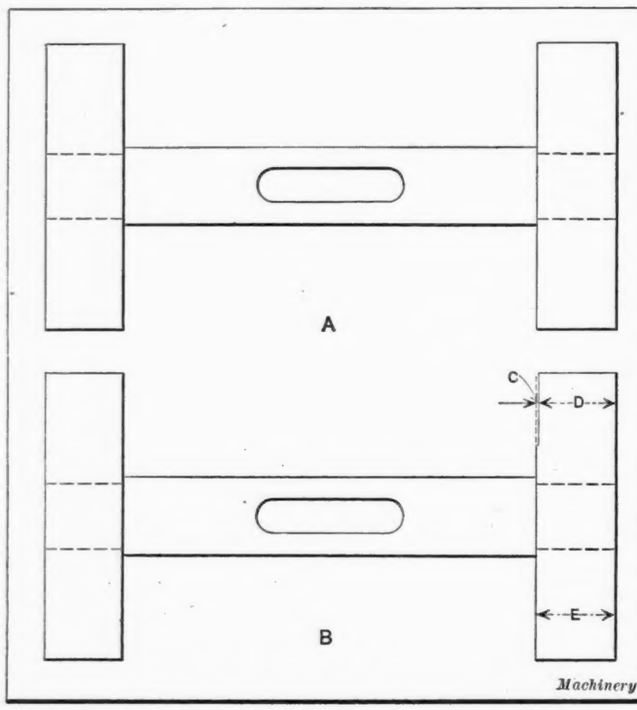

Fig. 2. (A) Limit Plug Gage for Large Work. (B) Combined Plug and Depth Limit Gage

A simple form of limit gage for testing a hole is shown at *X* in Fig. 1. Manufacturing standards for the principal dimensions of limit gages are slightly different in various factories, but the following system will be found satisfactory. *A* is always 3/8 inch, *B* 4 inches, *C* one and one-half times the diameter of the hole to be gaged, *D* 1/16 inch smaller than *E* and *F*, which, of course, are determined by the work to be inspected. The portion between the ends is knurled, and two flats are milled on opposite sides. These are for the purpose of stamping the part number and the gage sizes. Let it be assumed

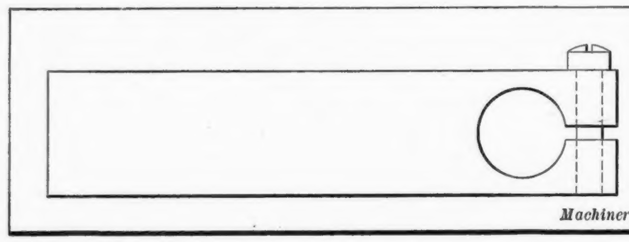

Fig. 3. Form of Lap used for lapping Plug Gages

that the hole to be tested is 7/8 inch and that a variation of 0.0005 inch is allowed; 0.0003 inch over size and 0.0002 inch under size. In this case the long end of the gage should be 0.8748 inch, marked "Go," while the short end is 0.8753 inch, marked "Not Go."

A form of limit gage called a two-step gage is illustrated at *Y* in Fig. 1. This arrangement is popular with many tool designers because the hole can be tested without withdrawing the gage to insert the other end, which would be necessary if using plugs of the type shown at *X*. This gage presents one decided objection, however, as it is impossible to tell what portion of the gage is bearing on the work in cases where the hole is slightly tapered. Notwithstanding this objection, these gages are frequently used by up-to-date concerns.

For testing comparatively large work it is not practicable to use either of these gages on account of the excessive weight involved. In cases of this kind it is a better plan to make the gage as shown at *A* in Fig. 2, with a handle having a disk forced on against a shoulder at each end. The disks are, of course, hardened and ground, while the handle, which can be a piece of cold-rolled steel, is left soft. This is an economical gage to maintain, as only the "Go" end wears rapidly. Thus the gage is cheaply brought up to standard by substituting a new disk in place of the one that is worn under size.

Fig. 2 illustrates at *B* a modification of gage *A* for testing the depth of a hole in cases where the shoulder must be within a certain distance from the face of the work. As an illustration, suppose it were necessary to maintain a limit of 0.002 inch in the depth of a hole one inch deep, allowing for 0.001 inch variation either way; it will be seen that part of the top of the "Go" end of the gage is ground away at *C*. The exaggeration in the drawing is for the purpose of showing the principle clearly. This ground portion *D* should measure 0.999 inch and is marked "Go," while the remainder of the disk *E* measures 1.001 inch and is marked "Not Go." In using the gage, a scale or other convenient straightedge is passed over the disk after it is inserted in the work. If it passes over the low portion and at the same time strikes the remainder of the disk, the work is within the established limits. If the straightedge passes over both portions of the disk, the hole is too deep, and if it strikes both portions, the hole is not deep enough.

Many manufacturers persist in making gages of a good grade of tool steel, which is a waste of expensive material and high-priced labor—a still greater factor; also it must be remembered that tool steel is a material that requires considerable time for machining. To be sure, a good grade of tool steel is to be preferred to a poor quality, which might harden in spots only. But why use tool steel at all—simply because grand-

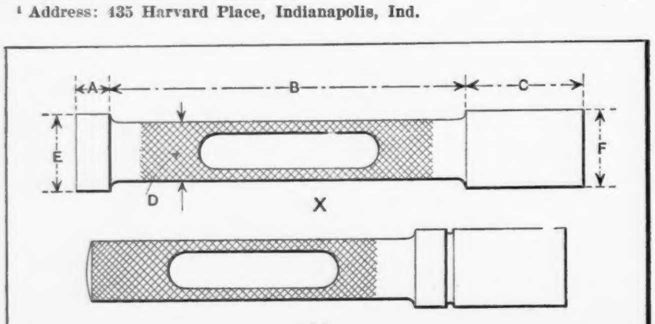

Fig. 1. Two Types of Limit Plug Gages for Small Work

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father did? In this age of rapid production it has been demonstrated time and again that ordinary machine steel carbonized to a depth of 1/16 inch will give entire satisfaction on the work in question, as it can be made extremely hard at slight cost.

The lathe work on the gages described is a simple operation for a tool-room lathe hand and requires no comment here, except to state that the pieces should be recentered before hardening. The reason for this is that heavy roughing cuts, together with the operation of knurling, distort the centers to a certain extent, and this is sure to cause trouble in the grinding operation. To insure further accuracy the centers should be lapped after hardening to remove the fire scale.

Grinding and Lapping Gages

There are three kinds of material used for gage grinding, *viz.*, emery, corundum and artificial alumina abrasives, the last being variously known to the trade as aloxite, alundum, etc. Some years ago all grinding wheels were termed emery wheels, as indeed they are today by the uninformed. Genuine Naxos emery, however, will always be used to a certain extent on very fine work, owing to the fact that it gives a high finish. To be sure, emery wheels are comparatively slow cutting, but as gage work is an exacting operation at best, the extra time spent in the grinding operation is often overlooked by the manufacturer who desires the best finish possible. Corundum wheels are often used for the work in question with excellent results, as corundum is really a high-grade emery in that it contains more alumina and less impurities than the best grades of emery. In selecting corundum wheels, care must be exercised to obtain only first quality goods, as poor corundum makes a very unsatisfactory wheel. Both emery and corundum are natural products.

The artificial alumina abrasives are faster cutting than the natural ones, and for this reason and because they are readily obtained from almost any reliable mill supply house, they are extensively used for work of this kind. These wheels can be run safely at high peripheral speeds, 6000 to 7000 feet per minute, whereas emery and corundum wheels should never, under any circumstances, be allowed to exceed 5500 feet per minute surface speed.

To state definitely the exact grit and grade of wheel to be used for gage grinding is an impossibility, as the conditions vary so greatly. As a general thing, however, grits 60 to 80 and grades K to N are used. In selecting aloxite wheels it must be borne in mind that their grade scale is the reverse of the ones commonly used. As an illustration, an alundum wheel in J grade is quite soft, while an aloxite wheel in the same grade is several grades harder. Full and sufficient information on this point is given in MACHINERY'S HANDBOOK.

Gage grinding differs but little from any cylindrical grinding operation, except that extreme care must be used in sizing the work to leave just the right amount for lapping, for while 0.0001 inch is of little consequence in grinding, it often proves a large amount to remove by lapping in cases where the work already has a mirror-like finish. The correct amount to leave for lapping depends on the grit and smooth cutting qualities of the wheel used. It is evident that a 60 grit wheel will leave deeper marks in the work than a 70 or 80 grit wheel. Again, a wheel that is properly dressed leaves a smoother finish than one that has simply been roughed up. In general, from 0.0002 to 0.0003 inch is sufficient allowance for lapping.

It is imperative that a slight amount should be left for lapping after grinding, no matter what kind of wheel is used; otherwise the friction between the work and the gage will soon wear the latter slightly under size. This is because any piece of ground work (no matter how fine a wheel has been used) always shows innumerable scores and high spots when examined under a microscope. The high portions would soon wear away after the gage is put in use, and the object of lapping is to wear the high spots away and bring the gage to a mirror-like finish, which will resist wear for a comparatively long time. There are several methods used for lapping cylindrical gages, the most crude and unsatisfactory being to polish them with fine emery cloth. This is poor practice at best, and it is never resorted to by the toolmaker who understands his business or prides himself on his work. Another method is to use a wooden clamp not unlike the polishing clamps used for finishing shafting some years ago. Lard oil and rouge are used, and good results are possible in the hands of an expert workman, as the rouge has not enough abrasive action to remove much more than the actual high spots. Great care must be taken while grinding to leave just the correct amount for lapping if this method is employed, for after the actual high spots are removed the rouge cuts the finished surface very slowly indeed. The writer recalls spending an entire afternoon in removing 0.0002 inch from a gage 1 inch in diameter and 3 inches long in a certain instance where it was desired to reduce a gage that had previously been finished.

The most practical method is to use a cast-iron lap and carefully washed flour emery mixed with lard oil. A lap of this kind can be easily made as shown in Fig. 3. It consists of any convenient piece of open-grained gray iron with a hole bored in one end to receive the work. The extra length serves as a handle. Laps of this kind should be split and provided with a screw for taking up wear, as a lap to do good work should fit the piece snugly. The lapping operation should not be hurried unduly, as this procedure will sometimes result in an under sized gage; and while there is always a chance of saving a gage that is a little over size, one that is under size is an absolute loss. The work should be washed in gasoline before calipering and then cooled in water that has stood in a bucket long enough to acquire the temperature of the room through radiation. Otherwise a very slight error will be apparent even though the work may be done by a competent workman.

Gages made by the above methods are, of course, not absolutely accurate when compared with the famous Johansson gages. However, they are accurate enough for regular commercial work, and as they can be made at low cost, no great expense is involved when they go to the scrap box after being worn to the point of uselessness.

* * *

BABBITTED MACHINERY CONSTRUCTION

There is a general prejudice against the use of babbitted bearings in high-grade machines, although they are widely used in so-called low-grade machinery, and give long and satisfactory service when properly cared for. The prejudice apparently arises from the fact that a babbitt bearing is soft and is easily ruined. But on the other hand, a babbitt bearing properly proportioned for the load it is to carry, and constantly lubricated, will last as long as the best bronze under similar conditions. This fact is appreciated by those who know how dependable a babbitted bearing is when so proportioned that the load pressure does not break down the oil film.

Babbitted bearings have the important advantage of being easily made by mechanics provided with ordinary limited means, and in case of failure they can be readily replaced. Another advantage of babbitted bearings, well known years ago but which has been lost sight of in the development of modern methods of manufacture, is that a machine can be erected with shafts in parallel and accurately located without expensive boring and other machining processes. With an equipment of babbitting jigs, it is feasible to use castings from the foundry with practically no machining preparation and build machines with dependable bearings in line and accurately located. We are likely to look scornfully upon such mechanical products as being unworthy of an up-to-date shop, but in the effort to produce machine parts of mathematical precision, we may have neglected methods proved by long experience to be dependable, and which under certain conditions are superior to modern methods.

The best method of building machinery depends upon the conditions of use, accuracy required and number of machines to be built. When the refinement is not great and the number to be made is small, babbitted bearings may well be considered favorably.

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The annual index of MACHINERY, Volume 22, which concluded with the August number, will be sent to any reader on request.

SOME NOTES ON STEAM HAMMERS

CHARACTERISTICS AND CAPACITY OF COMMON TYPES

BY JAMES CRAN[1]

TWO types of steam hammers are in general use, namely, single- and double-frame hammers, either of which may be of the open-frame order. Open-frame hammers are not provided with guides to keep the ram and the upper die in alignment with the anvil and lower die; they have, however, a much heavier piston-rod, either of round section with one flat side to keep it from turning, or of hexagonal form working through a long gland of corresponding shape. While the alignment of open-frame hammers is not as perfect as those provided with guides, the former can be used for a much wider range of work owing to the fact that they are accessible on three sides, having no guides to come in the way of irregular shaped forgings, and the operator has an unobstructed view of the work. The more common type of steam hammer with guides is not so convenient for the majority of work, but is better suited to making duplicate parts in quantities, as special dies can be kept in almost perfect alignment.

The single-frame steam hammer shown in Fig. 1 differs but slightly from most of the others of this type in general use. It is built to run automatically and the hammer will continue to strike the same force of blow as long as the steam pressure remains the same after the throttle valve is opened and the controlling lever set in its quadrant. The length of stroke and the force of the blow can be increased or diminished within certain limits after the controlling lever has been set, by changing the position of the throttle lever to admit more or less steam to the cylinder. The automatic attachment on steam hammers performs the same function as the eccentric movement on a plain slide valve engine, opening and closing the ports that admit steam to the cylinders, the difference being that the ports of a steam hammer are opened and closed by a reciprocating instead of a rotary mechanism. On the back of the ram inside the frame there is a shoe or slide upon which a cam lever attached to the fulcrum of the controlling lever works, a short lever on the end of the fulcrum shaft being attached to the valve stem by a connecting-rod at the back of the hammer for the purpose of controlling the vertical movement of the valve.

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Keeping up Efficiency

The efficiency of this type of hammer depends to a considerable extent upon the correct setting of the valves. When the valve is adjusted so that the hammer (when running automatically) will take just sufficient steam at the lower port to raise the ram, and will open the top port to its full capacity with the shortest possible travel of the valve, the hammer will work at its maximum efficiency and will hold pieces firmly between the dies by throwing the throttle wide open and setting the controlling lever at the lowest point of the quadrant. After a certain amount of service, steam hammers frequently get into such a condition that they will not hold pieces firmly between the dies on account of lost motion through wear of the various working parts that connect the controlling lever with the valve stem. The reason for this is that the valve does not rise high enough to completely close the exhaust opening. The remedy for a condition such as this is to shorten the valve stem, which is adjustable, in order to compensate for wear on the connecting-rod and levers.

While most steam hammers in general use are constructed to run automatically, this does not mean that all of them can be used without an operator, as only the smaller sizes, say from 250 to 600 pounds' capacity, can be used to advantage with a foot-lever connected with the throttle valve. A man doing small work can use the foot-lever without inconvenience after the controlling lever has been set for the desired force of blow, but he is obliged to have the free use of both feet when doing heavier work, and this usually calls for a wider variety of blows than can be had through a purely automatic system of control.

Capacity of Steam Hammers

It is a difficult matter to state definitely the capacity of a hammer as regards the size of work which it can handle to

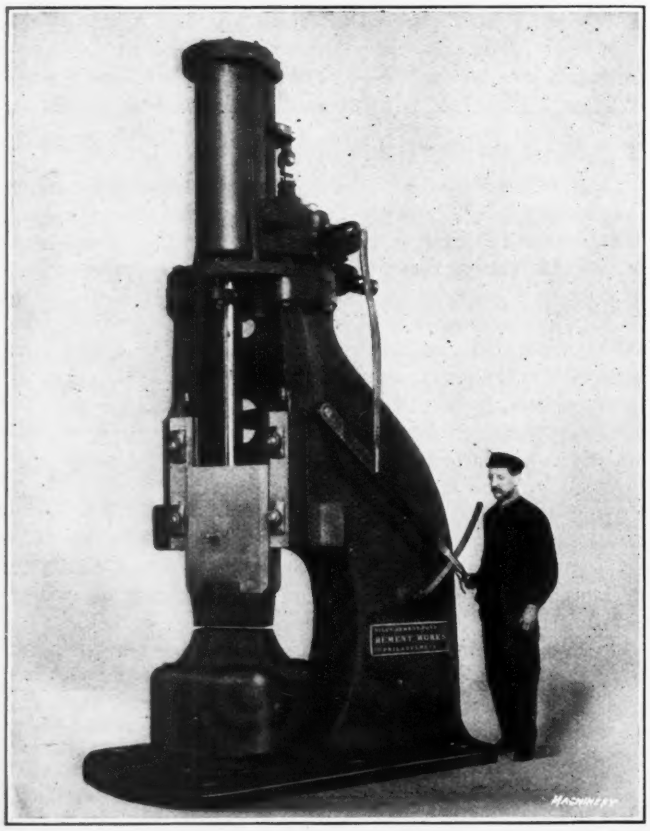

Fig. 1. Single-frame Steam Hammer

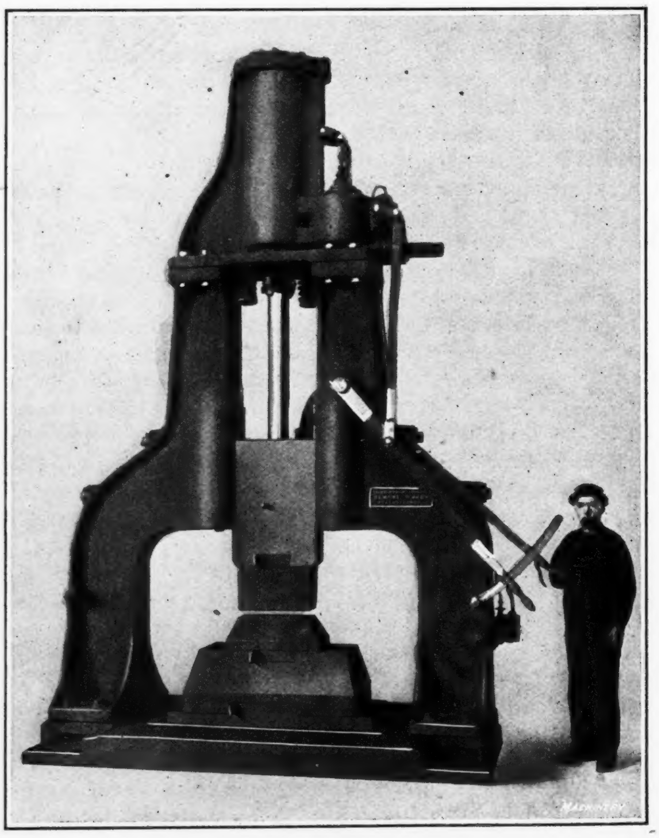

Fig. 2. Double-frame Steam Hammer

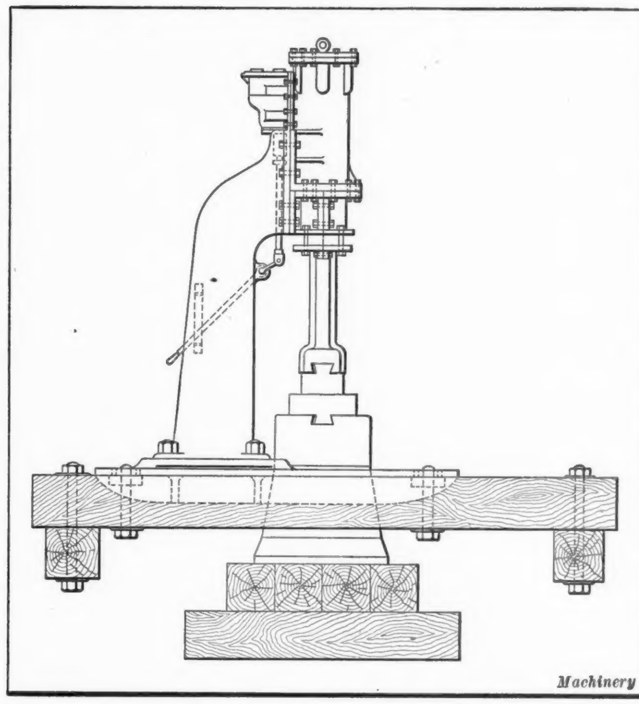

Fig. 3. Open-frame Steam Hammer with Foundation Details

advantage; there are so many conflicting factors which affect the situation that it is impossible to give anything like a rating that will cover all conditions. The following data[1], which are given out by a well-known builder of steam hammers, may be safely used as a basis for estimating the size of hammer needed for a given piece of work:

Diameter of Stock (Round or Square)	Size of Hammer, Pounds
3½ inches	250 to 350
4 inches	350 to 600
4½ inches	600 to 800
5 inches	800 to 1000
6 inches	1000 to 1500

One of the most common mistakes made in selecting a steam hammer is getting one which is too light for the work on which it is intended to be used. When a light hammer is used to draw down heavy stock to smaller size, the effect of the blows does not penetrate to the center of the material, and as a consequence the outside is drawn more than the inside. When this happens, it will be easily discernible by examining the pieces, which will be found to be concave on the end. When the hammer is of sufficient size, the ends of the pieces drawn down will be convex, showing that the effect of the blows has penetrated to the center of the work.

If it were possible to operate steam hammers at all times with a full stroke and steam pressure at 100 pounds per square inch, it would be comparatively easy to give a rating for the different sizes, but as the variation in both steam pressure and length of stroke must be taken into consideration, the problem is more difficult. It will be readily seen that when a full length stroke of the hammer can be used in working under a full head of steam, the results both from momentum and steam expansion are very much greater in proportion than when a short stroke is used. Some of the information given out by the manufacturers of steam hammers is rather misleading to those not familiar with forging work. For example, an occasional forging may be made on a much smaller hammer than would be used for making the same piece in large quantity production. While forgings such as a 6-inch pinion or a short shaft can be made on an 800- or 1000-pound hammer, one of 1500-pound weight would be required to produce the same pieces in large quantities. To get the maximum output of 6-inch axles which must be forged from much heavier stock than the dimensions imply, a hammer from 6000 to 8000 pounds' capacity will be required. From the foregoing it will be seen that the selection of a hammer is dependent largely upon the work for which it is intended, and judgment must be used in regard to production and other factors mentioned.

Double-frame hammers differ from those described only in the shape of the frame, which is made in the form of an arch, the sides of which act as guides for the ram, the anvil being in the center, as will be noted by referring to Fig. 2. The open-frame steam hammer shown in Fig. 3 is a machine that merits more attention than has generally been given to it, owing to the fact that hammers of this type are to be found to some extent in nearly all factories where the making of forgings forms an important part of the work.

This hammer is simple in construction, as it has fewer working parts than any other machine of the same kind. By referring to the illustration, it will be seen that it is provided with only one lever, which performs the double duty of opening the throttle and controlling the stroke. The first movement of the lever upward opens the throttle and also the lower port to the cylinder, which admits the steam to raise the ram. Thus it will be seen that the lever and ram work in unison and that when the lever is raised, the piston and ram rise, while for the downward stroke the lever is lowered, although not to the extreme end of the guide in which it travels.

A hammer of this kind cannot be operated automatically, but this is an advantage in some ways, because after a blow has been struck, the ram will not start on the return stroke until the lever has been raised. This prevents rebound and a second short stroke which often follows a full blow delivered by hammers having an automatic attachment when attended by a poor operator. Another feature of this hammer is the absence of safety buffers which are intended to prevent the piston rising too far in the cylinder. This is taken care of automatically by a number of small ports near the top of the cylinder, which are arranged so as to admit just sufficient steam to act as a cushion. The piston when raised beyond a certain point moves automatically until the steam pressure under it has been released. The operation of steam hammers is a knack acquired by practice, and young boys generally become the most expert in this work. Science does not enter into the operation in any way.

In conclusion, a little may be said in regard to foundations. While most steam hammer manufacturers send out drawings and specifications to cover this part of the subject, the nature of the ground upon which the hammers are to be installed should always be taken into consideration. In sand or clay soil it is advisable to have the foundation of concrete up to within 6 inches of the anvil base and covered with a wooden cushion to bring it up to its full height. When a rock bottom is found, the pier of crossed timbers usually specified will give satisfaction.

* * *

GROWTH OF STEEL PIPE AND TUBE INDUSTRY

In no branch is the growth of the steel industry so apparent as in the manufacture of pipes and tubes. Between the years 1887 and 1905 this growth was steady from almost nothing to a tonnage that required 938,198 tons of skelp. Since then the growth has been more erratic, yet in the next ten years the demand for skelp grew to 2,037,266 tons. This growth was due partly to the reduction in the demand for wrought iron, but mostly to the increased use to which pipes and tubes have been put. Instead of being utilized mainly for the conveyance of water and steam, they are now employed in the manufacture of agricultural implements, automobiles, bedsteads, building columns, refrigerating machinery, hospital furniture, dry kiln apparatus, ornamental fences, flag poles, wheelbarrows, work benches, elevator grain spouts, playground apparatus, signal towers, lunch counter stools, etc. Still the popularity of the steel product over wrought iron is shown by the steady decrease in the use of the latter. In 1905, wrought iron pipe manufacturers required 452,797 tons of skelp and made 31.05 per cent of the pipes and tubes; in 1910 they required only 350,578 tons of skelp, for their share of the market had fallen to 19.02 per cent; in 1915, this had fallen to 11.4 per cent and they used but 262,198 tons of skelp.

[1] The rule given in MACHINERY'S Handbook for the rating of steam hammers is: "Multiply the area of the piece to be forged in square inches by 80"; the result is the required falling weight in pounds. For example, a forging 4 inches square would require a falling weight of $4 \times 4 \times 80 = 1280$ pounds. This rule gives the weight considerably heavier than that recommended in the foregoing, and may perhaps be excessive for many conditions of ordinary service.—Editor.

STORAGE OF ENERGY

BY GEORGE P. PEARCE

In physical problems, the storage and release of energy frequently plays a more important part than is generally realized. Take a carpenter's chisel, for instance; the one with a long wooden handle cuts better than the one with a short, stubby handle under similar blows from the mallet. But how many have considered that the reason is due to the actual increase in energy that can be stored in the longer handle and released as a "push" for a longer time at the cutting edge? It gives more of a paring cut and less of a blow. The machinist using a two-pound mallet could deliver just as much energy to the chisel end of a wooden-handled cold chisel as when striking steel with steel, but he would not be able to chip as much metal. The reason, of course, is that the wooden handle will absorb the energy of the blow which would otherwise be instantly delivered at the cutting edge. The energy so absorbed is expended in rebounding the hammer, not in cutting the metal. The stiff chisel absorbs very little energy, it practically all being expended in cutting.

If a shaft is swung at the end of a rope and caused to hit something "end on," it will deliver a tremendous blow, because the steel shaft is in such a shape and condition that it cannot absorb much energy, and so it has to deliver it instantly. But if the shaft is turned sideways or coiled like a helical spring, it will no longer deliver the same smashing blow, although the amount of energy involved is precisely the same. The shaft can now store more energy and parts with it over a longer period of time; it gives more of a push and less of a blow. In one instance, it was impossible to speed up some automatic machines until the counterweights, which held the slides against the cams, were replaced with springs. Gravity could not deliver energy fast enough to the slides to keep them in contact with the cams.

A mild steel bar in direct tension does not make a good spring, because it does not absorb and return much energy; in fact, it will take up and restore from 5 to 8½ foot-pounds of energy only per pound of steel. Spring steel will take up 30 foot-pounds per pound in direct tension at 80,000 pounds working stress. A shaft in torsion is sometimes used as a spring; for instance, in some self-closing screen doors, because steel stressed under these conditions will absorb about 46 foot-pounds per pound of material. Helical springs are used because when the steel is so placed it is capable of absorbing 88 foot-pounds per pound of spring. But the energy absorbed is the same for a shaft or helical spring *at the same working stress*. A good rule to remember when determining the size of spring required for any purpose is: "Divide the foot-pounds of energy to be absorbed by 88"; the result will be the approximate weight of the spring in pounds.

Years before Professor Langley made his flying machine, a Frenchman made simple toys, which were driven by twisted elastic bands, that would fly fifty feet or more. These simple toys could fly because it is possible to store considerable energy in rubber; in fact, it is superior to the finest tempered steel spring in this respect, for almost 3000 foot-pounds per pound can be absorbed and delivered.

The flywheel is generally looked upon as an ideal device for the storage of power, but a cast-iron wheel reaches its limit at about 640 foot-pounds per pound. The energy of a good steel flywheel, however, will run up to around 3200 foot-pounds per pound. The energy of ordinary flywheels sinks into insignificance, though, when compared with that stored in the rim of a DeLaval steam turbine disk, where it may reach 31,000 foot-pounds per pound. The most efficient electric storage batteries cannot equal this, as they reach their limit at approximately 22,000 to 30,000 foot-pounds per pound, and many commercial batteries on the market do not exceed 3200 foot-pounds per pound of weight.

Ordinary air, when highly compressed, say around 2000 pounds per square inch, is capable of delivering 50,000 foot-pounds per pound, and is used for storage purposes in compressed-air-driven mine locomotives. But it is inferior to steam, which will deliver 240,000 foot-pounds of energy per pound when expanded from 250 down to 2 pounds pressure per square inch absolute.

If it is desired to obtain still more energy per pound, it can be found in fuels. Carbon, together with the necessary air to burn it, will deliver a little more than 900,000 foot-pounds per pound of mixture. Fuel oil, with air, will give 985,000 foot-pounds. Gunpowder has stored in it 1,000,000 foot-pounds per pound, while hydrogen and air give 1,362,000 foot-pounds, and hydrogen and oxygen mixed in the proportion of 1 to 8 give 5,365,000 foot-pounds of energy.

This may seem to be the limit, and it is a hard figure to beat, but there are everyday occurrences which are not much thought of and yet which represent much more energy than this. A common shooting star, which is seen almost any clear night, should average about seven miles per second—the velocity of a body falling from a very great distance upon the earth. These meteors give up to the earth and atmosphere 20,000,000 foot-pounds per pound. Meteors certainly have tremendous possibilities, but the old earth itself in its revolution around the sun has in every pound of its mass kinetic energy of 149,000,000 foot-pounds. But this force, enormous as it is, sinks into insignificance if some of the physicists are correct in their estimate of 1,400,000,000,000,000 foot-pounds as the total contained energy in one pound of radium. This agrees closely with the theory of ultimate velocity of material particles. Electrons have been observed having a velocity of 50,000 miles per second, which gives a kinetic energy of 108,000,000,000,000 foot-pounds. According to the electromagnetic theory of light, the maximum velocity which a material particle may have is 186,000 miles per second, which means a kinetic energy of 14,995,000,000,000,000 foot-pounds per pound.

[1] Address: 533 Tenth Ave., Moline, Ill.

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DANGERS OF HORSEPLAY

Many serious accidents happen in machine shops as the result of practical jokes, fooling and horseplay. A shop messenger was passing through a shop carrying a small can of gasoline. A would-be "Smart Aleck" working at a lathe turned around and knocked the can from the messenger's hand, spilling the gasoline onto his clothing. He happened to be near a lighted torch and the gas caught fire, causing serious burns of the messenger's arms and hands before the flames could be extinguished. The result was two weeks in the hospital and scars that will remain through life.

Throwing objects to attract attention or to annoy is especially dangerous practice. Serious injuries often result, especially if the missiles strike the eyes. To prevent horseplay without inflicting needless hardship is the problem of every shop management. One of the best ways of keeping men out of mischief is to keep them busy. The man who is always busy does not concern himself about his neighbors' business, nor does he indulge in unseemly and rude remarks. The ill-disciplined shop is generally one that is poorly managed as regards the distribution of work and constant employment of the men.

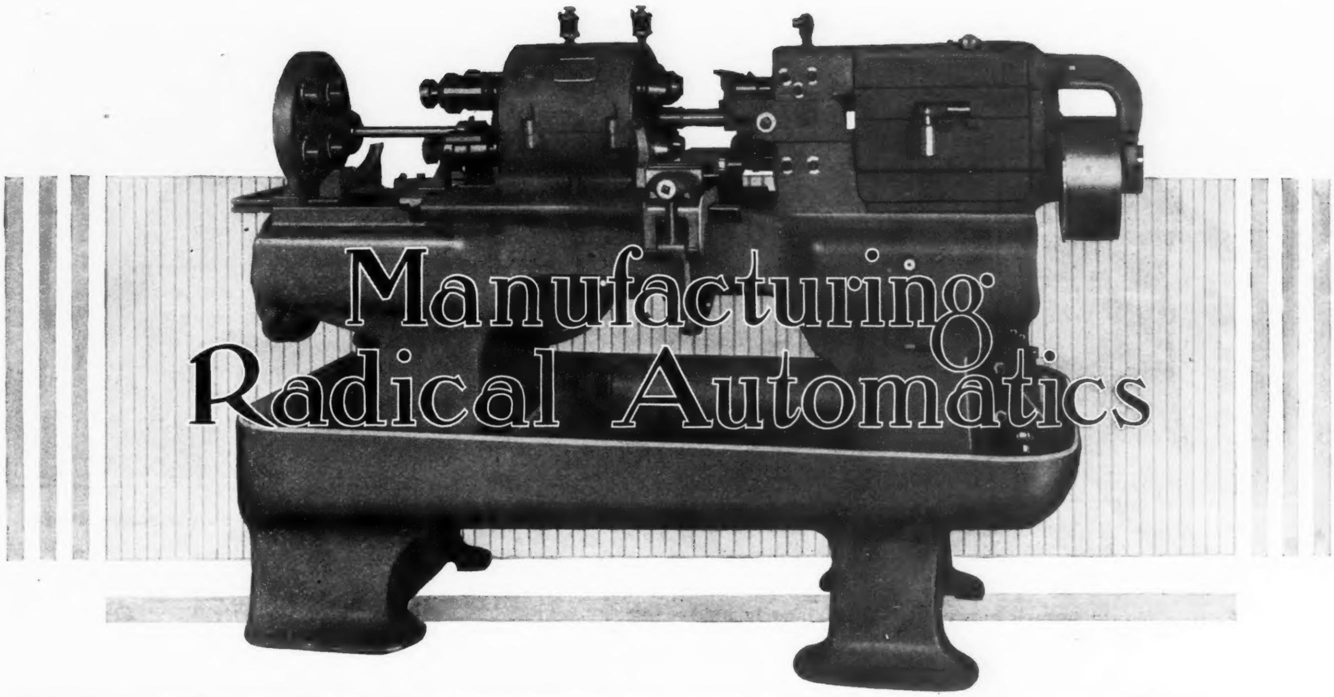
* * *

NEW RAILWAY STATION IN LEIPSIC

The new central station in Leipsic, which the German railway authorities completed in December, 1915, is the largest and one of the most convenient and luxurious railway terminals in Europe. Its construction was planned approximately thirty years ago, and work on it has been going on since 1901. The entire structure covers an area of 168,000 square feet, the main building having a front 984 feet long, and two wings, each 295 feet wide. The train shed is 785 feet long and contains twenty-six tracks. It is covered by a high roof of steel and glass built in the form of six arches.

It has been asserted that the Leipsic station is the largest in the world. It is probably the largest in Europe, but it is doubtful if it is as large as the Grand Central or the Pennsylvania station in New York. The station, although perhaps the busiest station in Germany, is not as busy as some of those elsewhere in Europe, notably the Gare St. Lazare in Paris—the busiest in the world—and the Liverpool St. station in London, both of which handle twice as much traffic as the busiest American station—the South station in Boston.

Manufacturing Radical Automatics



WHEN jigs and fixtures are used in manufacturing machine tool parts, the well-known advantages of interchangeability and higher rates of production are obtained; and the feature of interchangeability of parts is of exceptional importance when the machines are of a class extensively used in both domestic and foreign industries. But despite the benefits secured through the use of suitable manufacturing tools, there are many factories engaged in building machine tools which still rely upon expert workmanship and hand fitting to control dimensions of parts, instead of using jigs and fixtures that would not only insure a higher degree of accuracy than could be obtained by the best work done by hand, but would also effect a material increase in rates of production. Visitors to the plant of the Fitchburg Automatic Machine Works, Fitchburg, Mass., who are given an opportunity of making a careful study of the methods employed in manufacturing "Radical" automatics will be impressed by the exceptionally simple design of these machines and the small number of parts, as well as by the complete equipment of jigs and fixtures that has been provided to insure accuracy in the fitting of all important parts. It is the purpose of the present article to describe a part of this company's manufacturing practice, the aim being to show what excellent results may be obtained through the use of jigs and fixtures in machine tool shops.

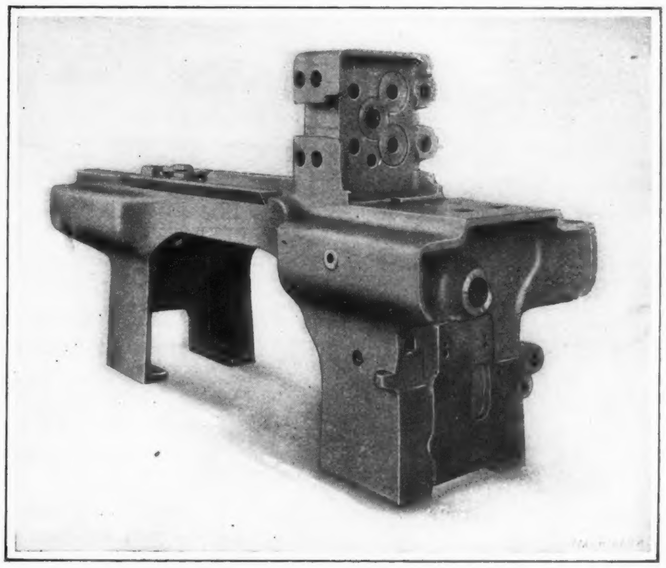


Fig. 1. Finished Bed of "Radical" Automatic ready to go to Assembling Department

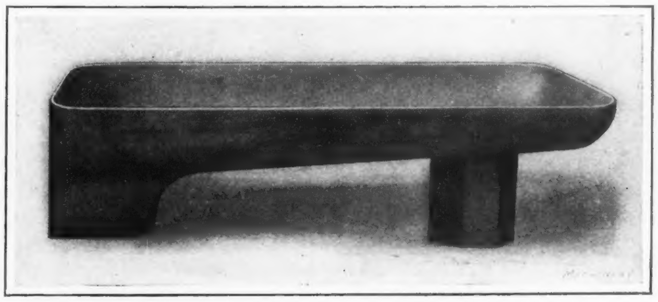


Fig. 2. Aluminum Pattern which produces Perfect Pan Castings

Machining Operations on the Bed

In conducting subsequent machining operations on the bed, the carriage ways are used as locating points, and the first operation consists of setting up the bed casting in a planer fixture and planing the ways. After this has been done, the casting is transferred to a Universal boring machine, on which the cam-shaft bearing holes are bored in the proper relation to the ways, and when this operation has been completed both the ways and cam-shaft bearing holes are used as locating points. The bed casting is next set up in a boring mill fixture, in which it is located from and rests on the planed ways; and this fixture provides for rough-boring all holes in the tool knee and the driving shaft bearing holes, and for finishing the gage stop hole. After this, the indexing lever holes are drilled through a jig in which the work is located from the cam-shaft bearing holes. The jig used for drilling the holes in the bosses through which the threading mechanism rods pass locates the work from the finished tool knee holes and the planed ways; and a similar jig provides for drilling and reaming all the speed gear-box holes. Another jig provides for locating, drilling or boring and reaming all holes in the bed required for bolting and pinning the worm bracket, feed gear-box, driving shaft bracket, and oil pump bracket to the bed; and the saving of time effected by machining all these holes at a single setting of the work is obvious.

Early experience in casting the pan for "Radical" automatics showed that trouble was experienced from shrinkage cracks and rough surfaces when molding was done from a wooden pattern; and to overcome this difficulty an aluminum pattern was made, which is filed and polished so that the surface is extremely smooth. This pattern, which is shown in Fig. 2, may be lifted from the sand without any trouble, and molds made from it produce perfect castings. A simple drill jig is provided for drilling the holes in the bed feet, pan and pan feet, which are required for bolting the bed to the pan and the pan to the floor. Construction of this jig follows familiar practice in tool design.

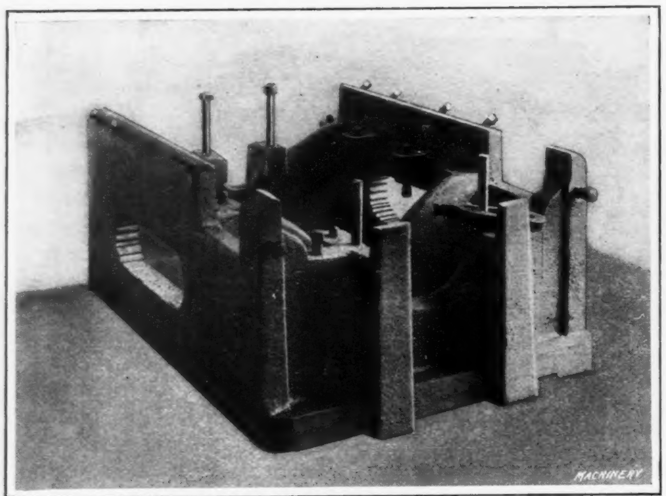


Fig. 3. Planer Fixture in which Carriage is held while planing Ways, Cross-slide Lever Bosses and Other Surfaces on Under Side

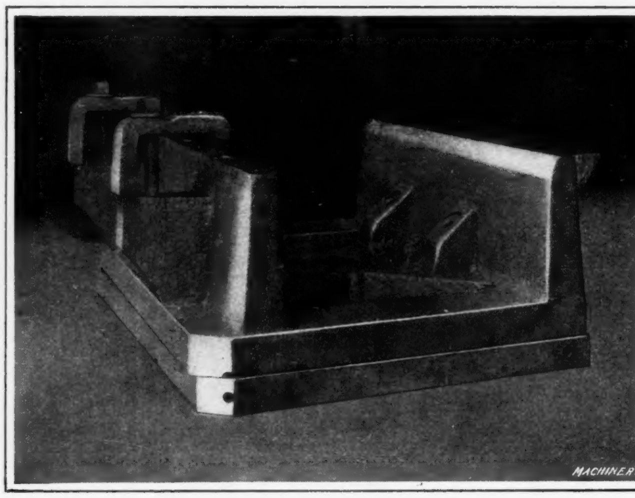


Fig. 4. Fixture mounted on Swivel Base to provide for planing Bearing for Taper Gib in Cross-slide

Machining Operations on the Carriage

Fig. 3 shows a planer fixture in which the carriage is held for planing the under side. While held in this fixture the ways are first machined, and accuracy in this part of the work is of great importance, because the ways are used as locating points for subsequent operations, as previously mentioned. In addition, the cross-slide lever bosses are planed and all other finished surfaces on the under side of the carriage are taken care of at the same setting. For the performance of these preliminary machining operations on the carriage, the rough surface of the casting is used as the locating point, the work being supported by screws which are clearly shown in the illustration; and four set-screws at each side of the fixture provide for holding the work down with the assistance of strap clamps.

When the machining of the under side of the carriage has been completed, the casting is transferred to the planer fixture shown in Fig. 4, in which the work is held while all the top surfaces are planed with the exception of the bearings for the cap. The work is located from the main ways to provide for locating the cross-slide exactly at right angles to them; and it will be seen that the upper part of the fixture swivels on the base, graduation marks being provided at one corner to enable the fixture to be moved through an angle of one degree in order to plane the taper for the cross-slide gibs. Jacks are provided to give adequate support for the work at all points. All planing operations on top of the carriage can be performed in the fixture shown in Fig. 4, with the exception of planing the cap bearings which are located at an angle. For handling this part of the work, the casting is transferred to a fixture shown in Fig. 5, which has a tapered base for holding the work at the required angle. As in the previous case, the work is located from the planed carriage ways.

The next operation on the carriage consists of drilling, boring and reaming all holes, and a fixture shown in Fig. 6 has been developed for this purpose which enables the entire

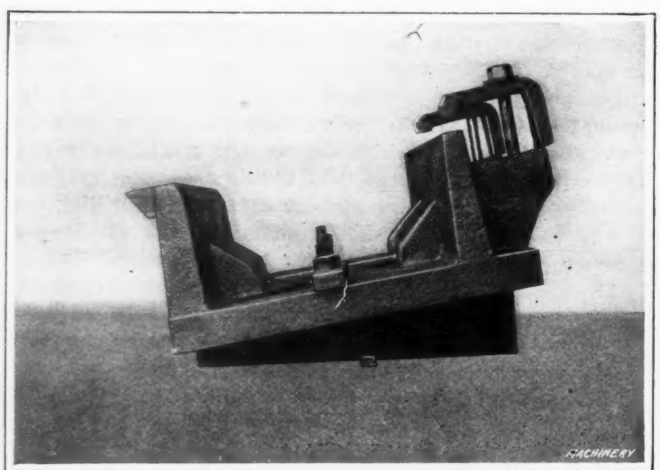


Fig. 5. Fixture held on Tapered Base to provide for planing Carriage Cap Bearing at Required Angle

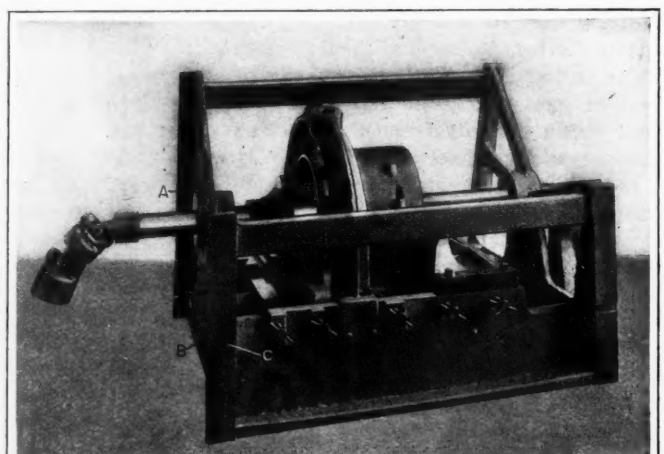


Fig. 6. Triple Based Fixture used for drilling, boring and reaming All Holes in Carriage at Single Setting

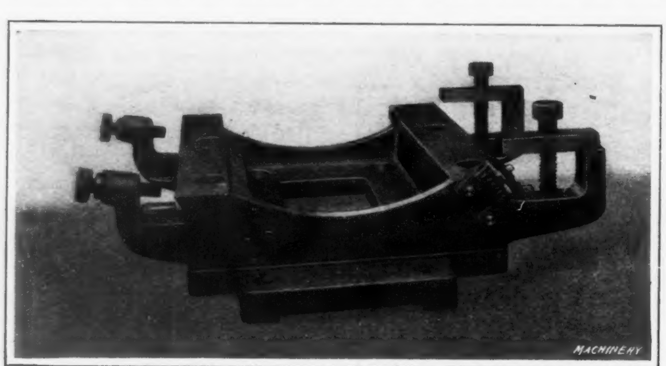


Fig. 7. Fixture used on Heald Planetary Grinder for grinding Cylinder Bearing in Carriage

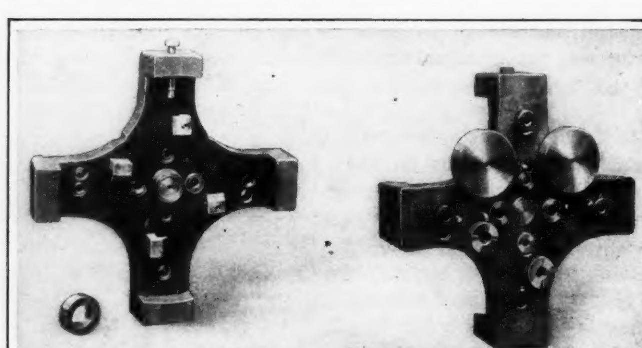


Fig. 8. Example of Multiple-purpose Drill Jig used in performing Four Operations

job to be done at a single setting. It will be seen that this fixture has three finished bases at *A*, *B* and *C*, which are slotted to provide for locating the fixture over a strip on the table of the Universal boring machine on which this operation is performed. The work is located from the planed main ways, and this illustration shows a special piloted boring-bar used for roughing out the two cylinder bearings in the carriage.

Grinding Cylinder Bearings in Carriage

A Heald planetary grinder is used for finishing the two cylinder bearings in the carriage, and while performing this operation the work is held in a fixture illustrated in Fig. 7. The table is removed from the grinding machine to enable this fixture to be mounted directly upon the bed. As in the case of the previous operation when the cylinder bearing was bored, the work is located from the main ways and strapped down on the finished locating surface on the fixture. Before being placed in this fixture, the planed ways of the carriage are carefully scraped to fit a perfectly accurate master bed in order to eliminate the slightest error in locating the work, as limits of accuracy on this operation are $\pm$ 0.00025 inch. After finish-grinding the cylinder bearing, the ends of the cylinder housing on the carriage are ground to accurate dimensions. The final grinding operation on the carriage consists of grinding an index-pin hole. A fixture provided for this purpose locates from the ground face of the cylinder housing and scraped ways of the carriage; this fixture is bolted to the table of a Heald planetary grinder which finishes the hole within a limit of accuracy of 0.00025 inch.

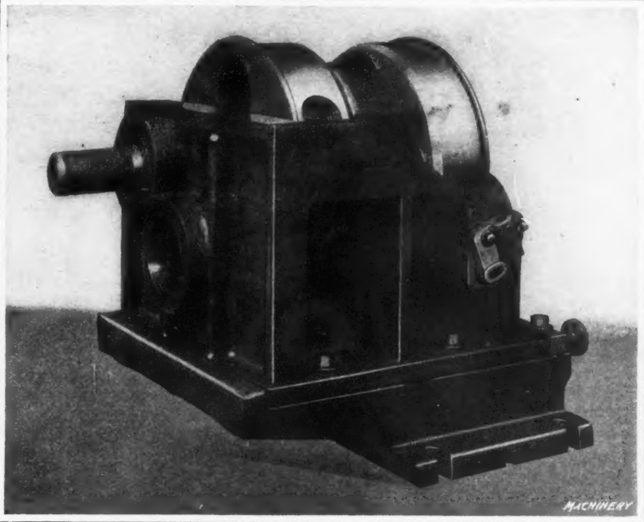


Fig. 9. Fixture used on Heald Grinder for finish-grinding Spindle Bearings and Index-pin Bushings in Cylinder

Grinding Operations on Cylinder

The two outside bearings of the cylinder which run in the carriage bearings are ground to an accuracy of 0.00025 inch on a grinder especially developed for this purpose by the Universal Grinding Co. A Heald planetary grinder is employed for grinding the spindle bearings in the cylinder and for grinding the index-pin bushing holes. The spindle hole and corresponding index-pin hole are located at right angles to each other, but the grinding of both sets of holes is completed in the fixture shown in Fig. 9. The spindle bearing holes are ground first, after which the fixture is turned through an angle of 90 degrees and the cylinder is reversed end for end in the fixture, so that the index-pin holes come opposite a cut-away section of the fixture and may be reached by the spindle of the planetary grinder. It will be evident that the work is located by a gage plug which fits in the ground spindle holes, as shown in this illustration, and the work is located in the fixture from the finished end and periphery. The spindle holes are ground within a limit of 0.0005 inch, both as regards diameter of holes and spacing between them; the lock-pin bushings are also held within the same limits.

Multiple-purpose Drill Jig

Factories engaged in manufacturing a large number of different parts that are required to be interchangeable often find the expense of jig and fixture storage a considerable item in their cost of production, even where no difficulty is experienced in keeping track of these tools. Obviously, it is an advantage to reduce the number of jigs and fixtures as much as possible, and this can often be done by making multiple-purpose tools. A good example of this kind is illustrated by Fig. 8, which shows opposite sides of a drill jig used for four distinct machining operations on the parts of this machine. This jig is used for drilling the index gear holes in rear of cylinder, independent gage stop spider, spider holes in front of cylinder, and wedge stop holes in rear of cylinder. All these operations are performed in parts closely related to the cylinder, and as the holes are distributed over areas of about the same size, it was found feasible to provide a single jig for handling them. Not only is the cost of tools reduced in this way, but such a practice in tool design is the means of materially reducing the amount of storage space required for jigs and fixtures. Tool designers in many factories where a lot of special equipment is needed for handling the work would do well to give this point careful consideration in working out their designs. In this way it would frequently be found possible to so group the operations that one tool could be made to serve for two or more purposes.

Fig. 10 shows a universal cam cutting machine used for producing the different forms of cams. It will be seen that the work is supported on centers in a headstock and tailstock carried by table *A* which is supported on slide *B*. The arrangement of the drive to milling cutter *C* and the means for transmitting motion to the rotary feed mechanism are clearly shown in this illustration, spur gear *D* being mounted on the headstock spindle to rotate the work. In addition to this rotary movement for feeding the work up to milling cutter *C*, provision must be made for securing the required longitudinal movement to obtain the required cam outline; and this is secured by means of wheel *E*, on which are mounted cam strips that engage with a roller secured to the end of table *A*. As wheel *E* rotates, contact of the cam strips with this roller results in imparting the necessary lateral movement to the table to secure the required outline. The roller is held in contact with the cam by a counterweight attached to the table. Wheel *E* and the cam strips

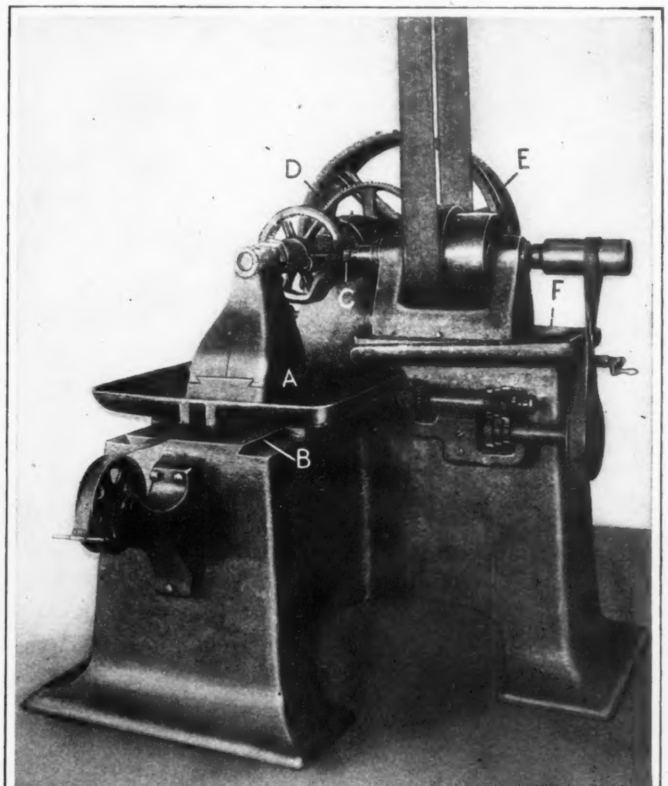


Fig. 10. Universal Cam Cutting Machine for making Cams used on "Radical" Automatics

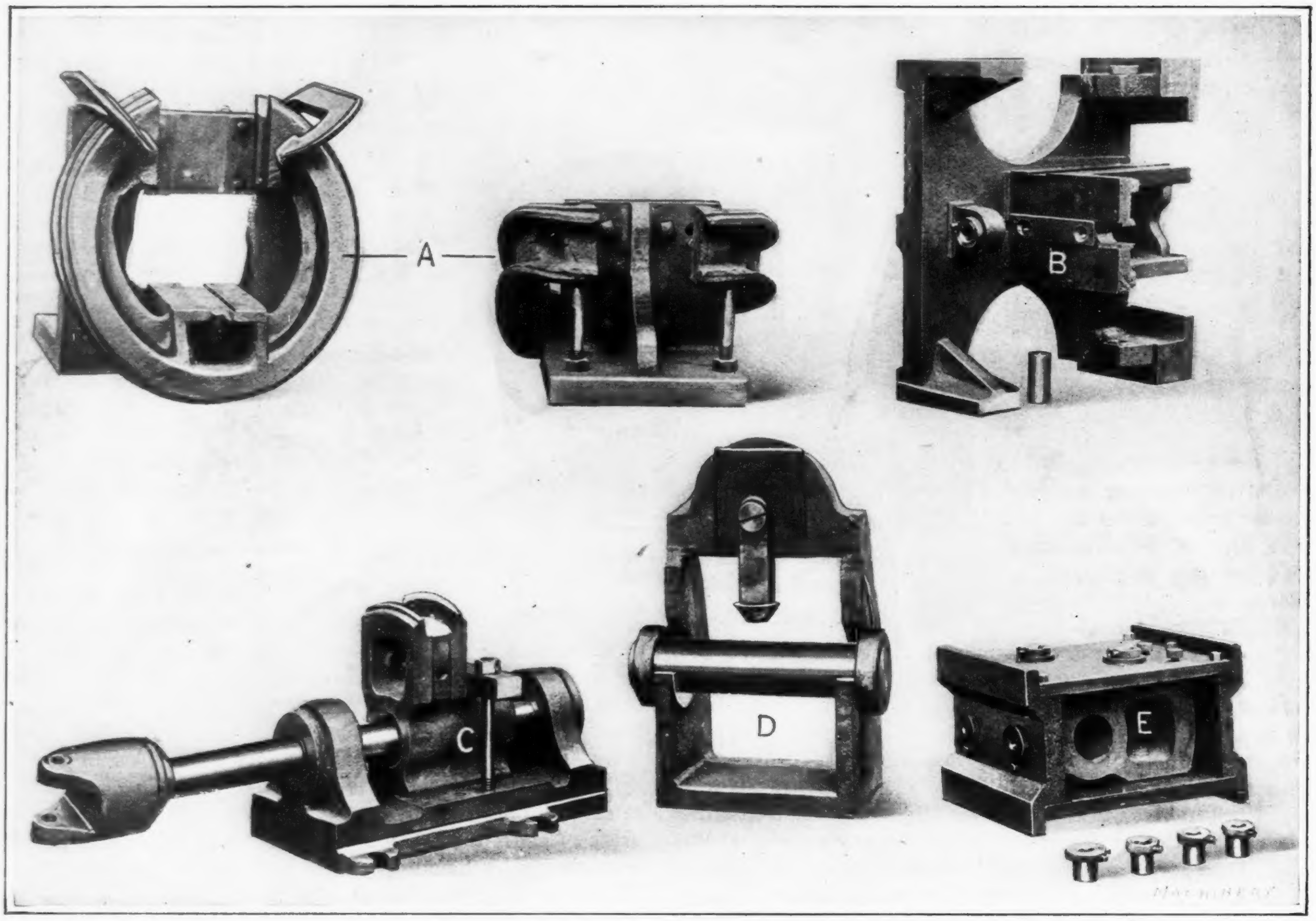


Fig. 11. A, Shaper Fixture for Lead Cams; B, Drill Jig for Lead Cams; C, Boring Fixture for Lead Cam Hubs; D, Die Cam Testing Fixture; E, Drill Jig for Lead Cam Hubs

carried by it are so designed that these strips may be set at different angles to provide for cutting the various forms of cams that are required. The cutter-head which supports milling cutter *C* is mounted on slide *F*, and to provide for cutting cams of various diameters the position of this head may be regulated so that milling cutter *C* is at the required distance from the line of centers on which the work is mounted when set up on the machine.

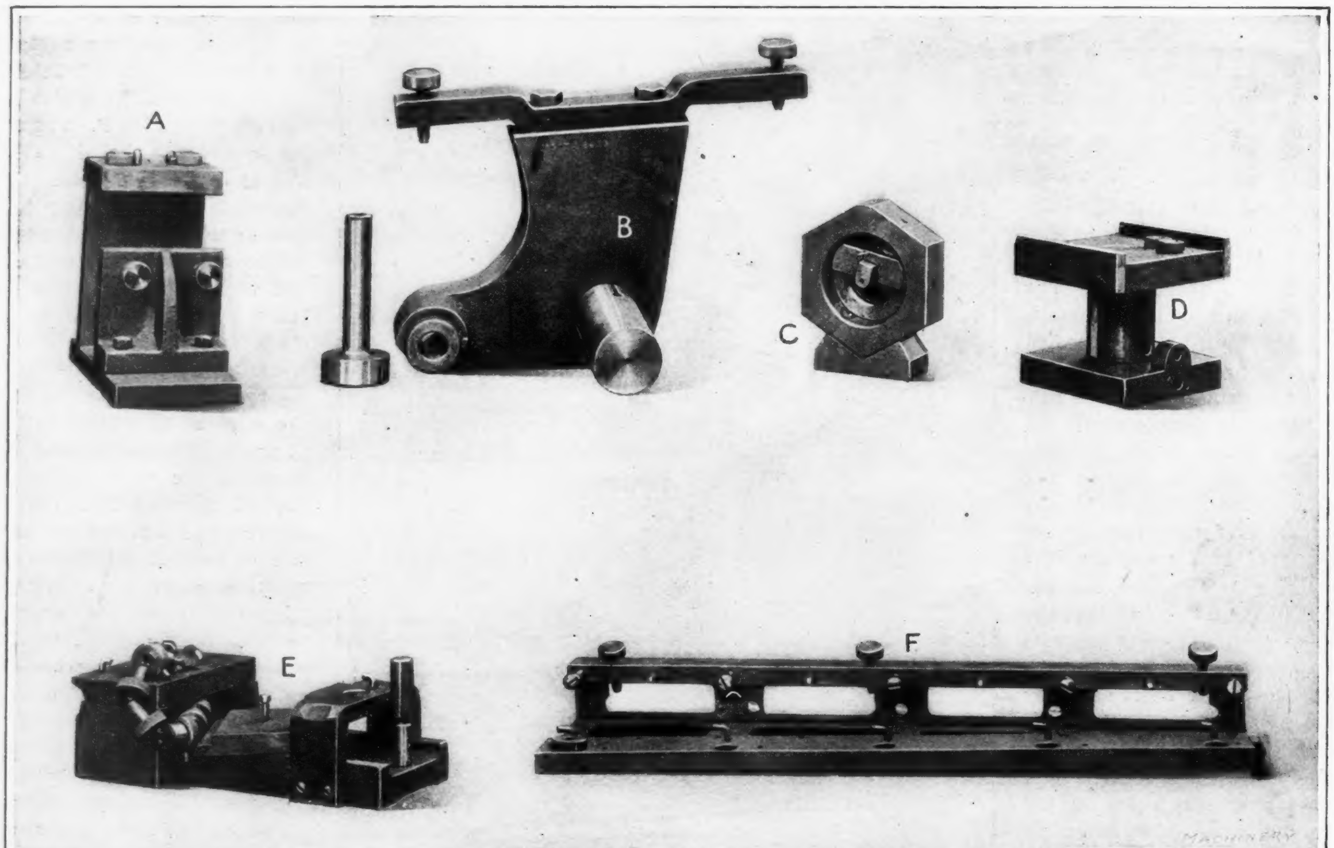


Fig. 12. A, Drill Jig for Cross-slide; B, Drill Jig for Index Lever Bearing on Bed; C, Drill Jig for Adjusting Nut for Spindle Rear Bearing; D, Drill Jig for Lock Bolt Cam; E, Drill Jig for Chuck Operating Slide and Shoe; F, Drill Jig for Cylinder Carriage Gib

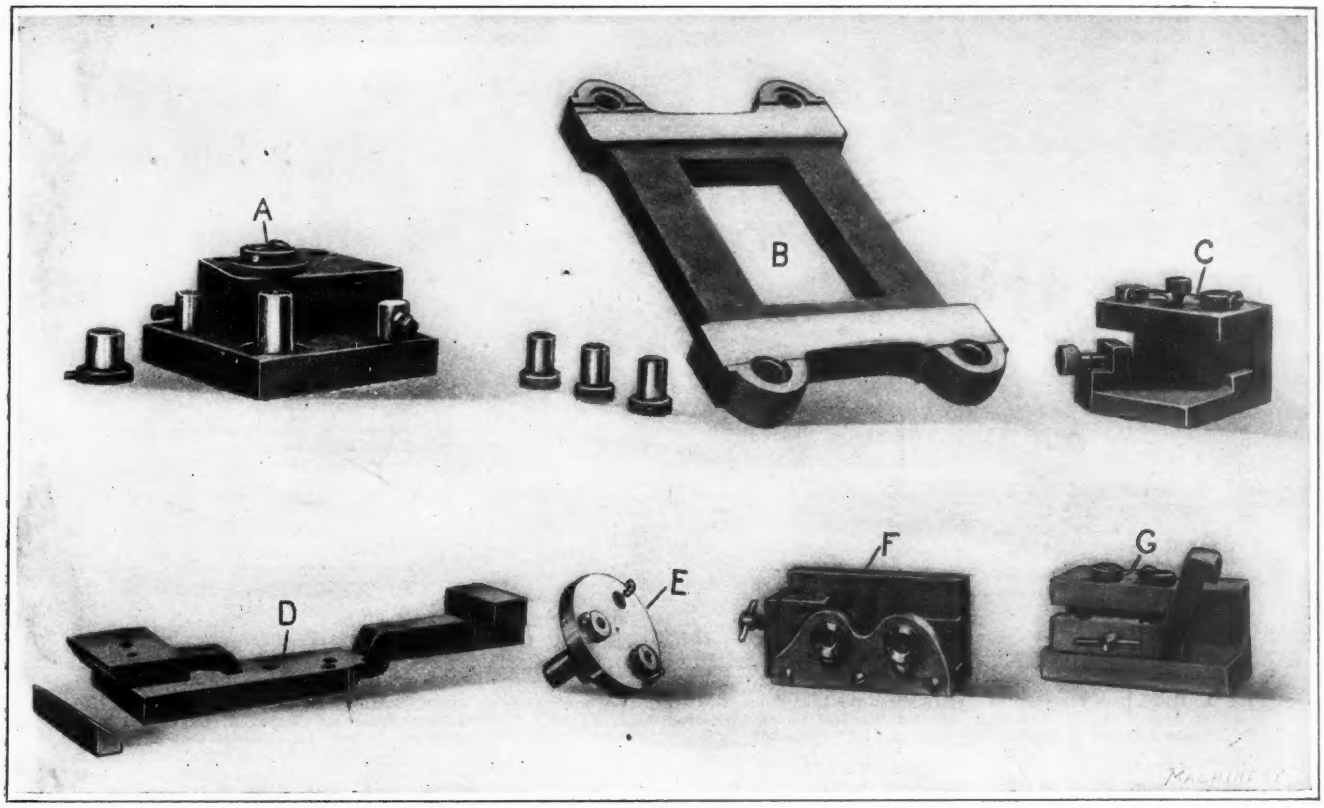


Fig. 13. A, Drill Jig for Index Levers; B, Drill Jig for Clamping Screws for Carriage and Cap; C, Drill Jig for Cross-slide Stop; D, Drill Jig for Cross-slide Cam Fork Bearing and Hole for Lock Bolt Spring; E, Drill Jig for Gear-box Pawl Holder; F, Drill Jig for Clutch Shifter Arm; G, Drill Jig for Feed Chuck Arm

Jigs and Fixtures for All Important Parts

The preceding description has covered in a general way the manner in which the machining operations are conducted on the bed, carriage, spindle cylinder and other parts. Lack of space precludes the possibility of presenting a complete description of all manufacturing methods, but it may be mentioned that wherever the accuracy of machine parts has an important bearing upon the perfection of the product, such parts are manufactured in jigs and fixtures so that their accuracy is insured. Figs. 11 to 14, inclusive, show miscellaneous examples of jigs and fixtures provided for machining various parts, and the captions which accompany these illustrations

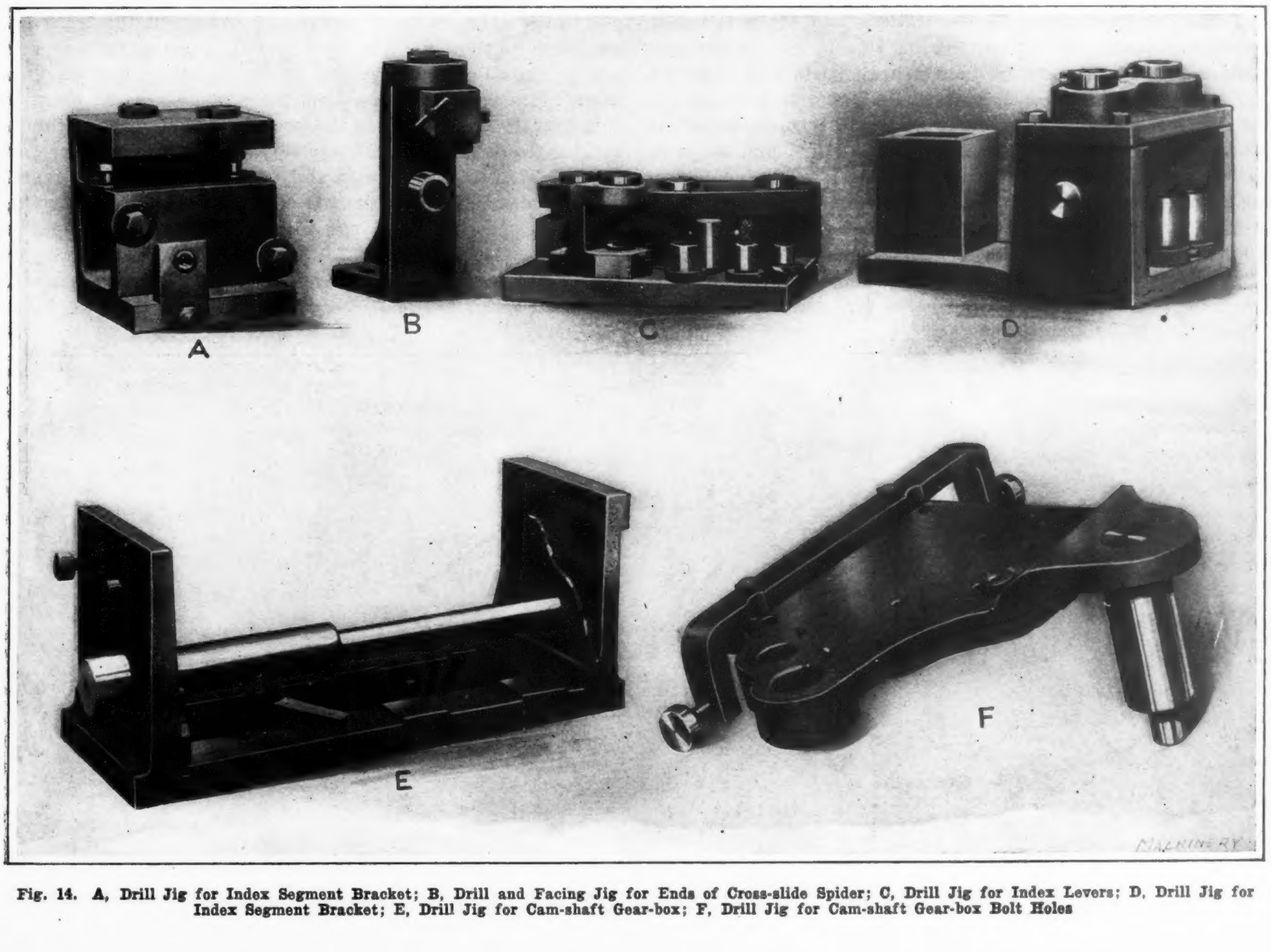


Fig. 14. A, Drill Jig for Index Segment Bracket; B, Drill and Facing Jig for Ends of Cross-slide Spider; C, Drill Jig for Index Levers; D, Drill Jig for Index Segment Bracket; E, Drill Jig for Cam-shaft Gear-box; F, Drill Jig for Cam-shaft Gear-box Bolt Holes

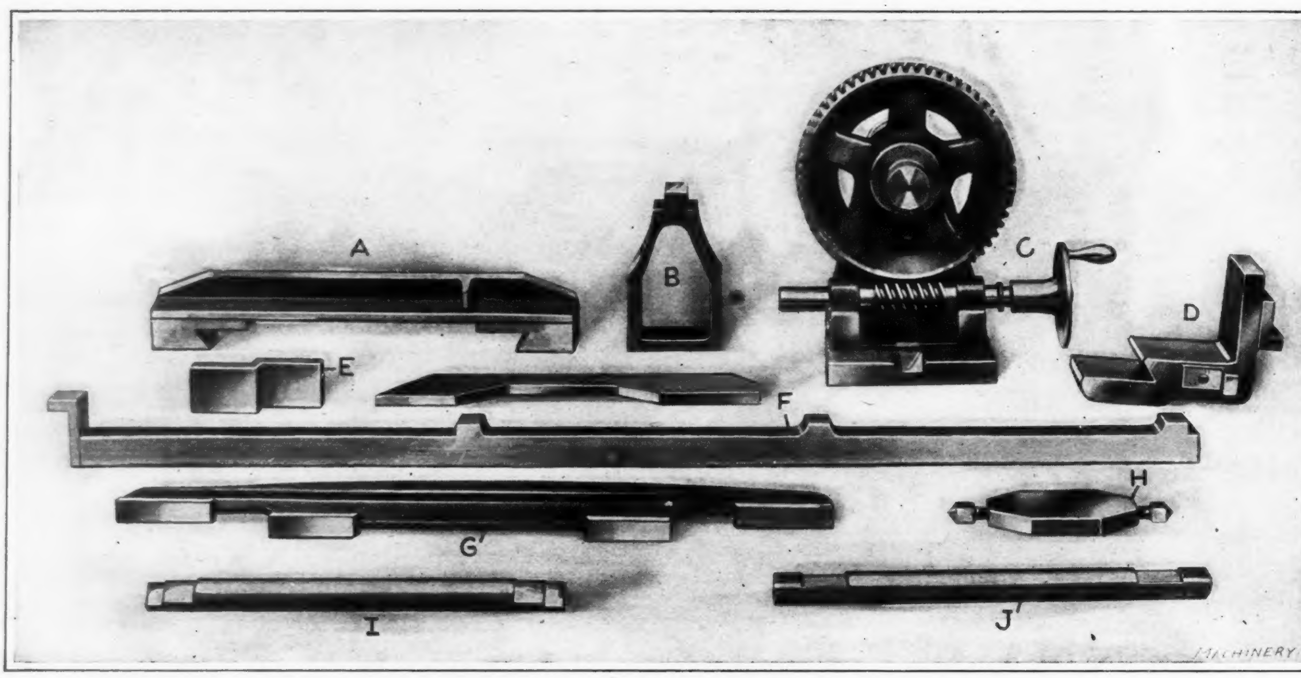


Fig. 15. A, Width Gage for Ways of Bed; B, Gage for Lead Cams; C, Cam-shaft Worm and Gear Testing Fixture; D, Gage for locating Index Bracket Faces from Ways; E, Locating Gage for Ways of Chuck Operating Slide; F, Gage for Gear-box, Table and Ways; G, Gage used with Boring Fixture; H, Center Gage used in planing Beds; I, Gage for Cylinder Carriage Cap Bearing; J, Gage for Cylinder Cap Bearing

give a brief explanation of the purpose for which each tool is used, which will be sufficient for any experienced mechanic.

Inspection and Gaging

As in all cases of manufacturing when a high degree of accuracy is required, it is necessary to take great care in inspection, and for use in handling this work the Fitchburg Automatic Machine Works have provided a complete set of gages and testing fixtures, miscellaneous examples of which are shown in Figs. 15 and 16. As it is not within the scope of this article to deal exhaustively with the manufacture of each part of the machine, no detailed description of these gages will be given; but from the illustrations and captions which accompany them, the reader will be able to gain a comprehensive idea of the manner in which all parts are inspected and tested for accuracy. Johansson limit and snap gages are used in inspecting and gaging work; and a complete set of Johansson block gages is used in making jigs and fixtures, testing micrometers, etc., so that provision is made for obtaining the maximum degree of accuracy. When this care is taken in manufacturing and testing all parts before they are assembled, the user of the finished machines is insured of satisfactory service; and he also has the advantage of being able to order duplicate or replacement parts for equipment he has in use with the assurance that such parts will go in place when they are applied without requiring fitting and realignment.

E. K. H.

* * *

NEEDLESSLY HEAVY RAILWAY EQUIPMENT

Henry Ford, the Detroit motor car manufacturer, struck the nail on the head when he criticized the useless dead weight of railway cars. The railways of the United States are generally equipped with cars made of low-grade materials, and as a consequence millions of tons of dead weight are hauled for which no compensation is received. This useless weight requires the expenditure of power and wears out the track and road bed needlessly. Mr. Ford stated that the railway companies could improve efficiency by cutting down the weight of their equipment, asserting that there is no greater waste in this country today than in the use of steel. Great weights in railway equipment are unnecessary and make for increased labor. The railway companies use steel having a tensile strength of about 60,000 pounds per square inch, whereas they might just as well use steel having a tensile strength of 200,000 pounds at very little increased cost. The use of the higher grade of steel would provide larger capacity cars with less dead weight.

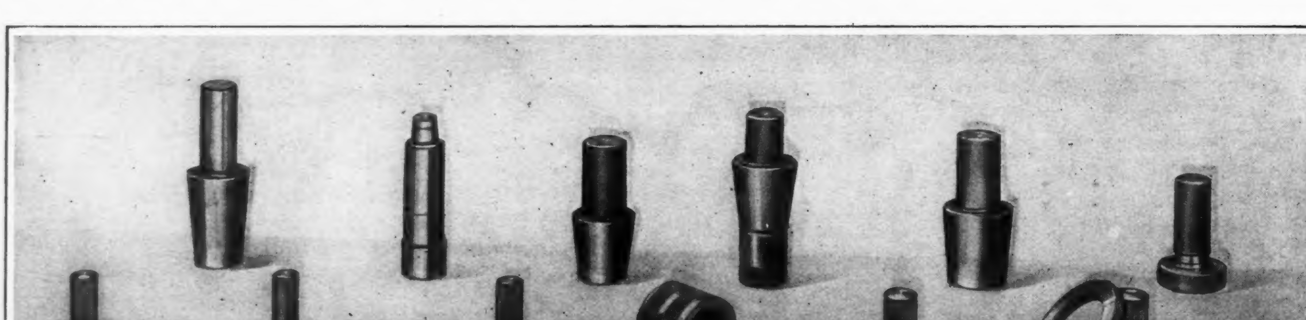


Fig. 16. Miscellaneous Collection of Plug and Ring Gages used in testing Parts of "Radical" Automatics

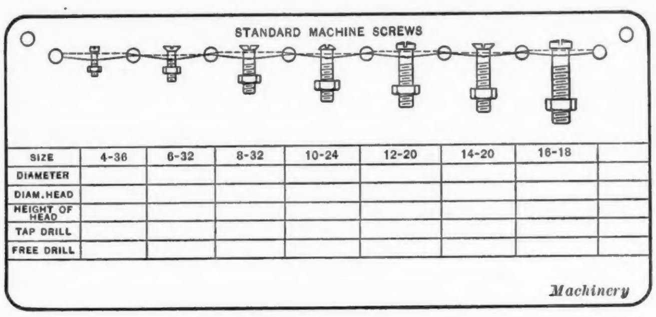
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

"MATERIALIZED" TABLES

In view of the fact that it is much easier to judge strength, size, etc., from the real article than from pictures or tables, it is convenient to have samples of all small articles, such as machine screws, cotters, taper pins, spring steel, sheet steel, small shafting and rods, wire, etc., conveniently mounted in some handy place in the drafting-room.

It has proved handy to mount them on cardboard in the manner shown in the illustration, which secures them in a definite position, and at the same time allows them to be handled if a little slack is left in the string. Metal eyelets should be used where the string passes through the cardboard, and in the corners for hanging it up. A string is put through the first eyelet, tied to the article to be fastened, through the next eyelet, across the back of the cardboard to the next eyelet, when it is again brought to the front of the board and tied to the article to be shown. This process is continued until the end of the cardboard is reached, when every alternate sample will have been fastened to the board. The string is then returned to the other end of the board in a similar manner and the remaining articles are fastened in place. Any information often made use of may be noted directly under the article to which it refers. For instance, the size and number of machine screws, diameter of screw, diameter of head, height of head, diameter of tap and free drills, etc.



Handy Chart for Drafting-rooms

Harvey, Ill. G. G. STEVENSON

FITTING TAPERS

I do not agree with the method of fitting tapers described by D. B. in the September issue of MACHINERY. It is all right for the lathe hand if the tapers are to be finished on a grinder, but I have used a method of fitting the finest taper fits that does not require the use of a special blue pencil or any marking material whatever. The majority of mechanics think they cannot get along without some kind of blue crayon, as it shows up well on brass and can be seen better on steel and cast iron than white chalk, but it is really unnecessary. My method of fitting tapers such as arbors and shafts to drill chucks and the endless category of machine tool spindles is as follows:

After the taper has been turned, leaving an allowance for filing, I take a piece of new emery cloth and make scratches lengthwise around the work. Then, when trying the fit, the bearing can be easily seen in the dull spots made by rubbing the internal and external surfaces together.

Winchester, N. H. WILBUR HATFIELD

With reference to the method of fitting tapers described in the September number of MACHINERY, the writer would say that rubbing Prussian blue or other color on the parts and wringing them together serves quite well when both surfaces are newly machined and true. But if one member has been used, or if a reamer used in the external member was not perfect, wringing gives misleading indications.

The writer has found the use of strips of paper satisfactory in all cases. The paper may be of almost any kind, but a thin grade of writing paper is preferable. As the strips should be used lengthwise of the work, they should have the same taper and should be about one-twentieth of the circumference in width. If there is just a trace of oil left on the taper member, the results are more easily read.

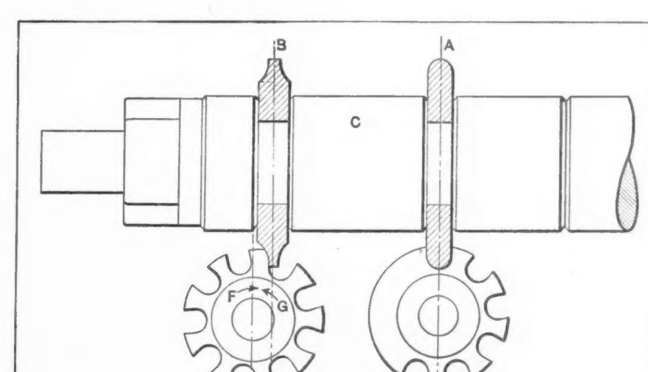
When the tapered members have been carefully put in their correct position, with the strips of paper between them, the strips being placed equal distances apart when more than one is used, the tapered parts are lightly tapped together. After they have been separated by tapping (not by wringing), a delicate and perfect record of both surfaces will appear on the surfaces of the paper. The objection to wringing such surfaces together is that any projection is likely to appear as a circular ridge, which it often is not, and a depression of the internal surface may not appear at all. Such paper prints of the condition of taper surfaces may be kept as permanent records.

Wilkinsburg, Pa. WILLIAM S. ROWELL

HOW WE CUT A FEW SPROCKET WHEELS

There were a number of nine-tooth sprockets for a half-inch roller chain to be cut. The tool-room did not contain a regular sprocket cutter, and the number of sprockets required was too small to warrant the expense of a cutter, so a 5/16-inch convex cutter *A* and a nine-pitch No. 8 gear-cutter *B* were mounted on a milling machine arbor, as shown in the accompanying illustration. By making the length of spacing collar *C* such that the distance between the centers of *A* and *B* was an even number of inches, the work of making the settings was greatly simplified, as it was then possible to move the cross-slide an even number of turns.

After the convex cutter *A* was set central with the dividing-head spindle and the cross-feed dial set at zero, the table was moved over and the gear-cutter *B* centered; its position was then noted on the dial. The table was then set back so that the convex cutter *A* was in line with the dividing-head spindle, the sprocket blanks were placed between the centers, and the nine gashes cut to the proper depth.



Method of setting Milling Machine

When all the blanks were cut, the table was again moved so that the gear-cutter *B* was in line with the spindle. The corners of the teeth were then formed to the proper shape by setting the table slightly off center in direction *D* and rotating the blank in the direction shown by the arrow *F*, to bring one side of the tooth against the cutter. The amount of this offset was found by experiment. As soon as the complete cut had been

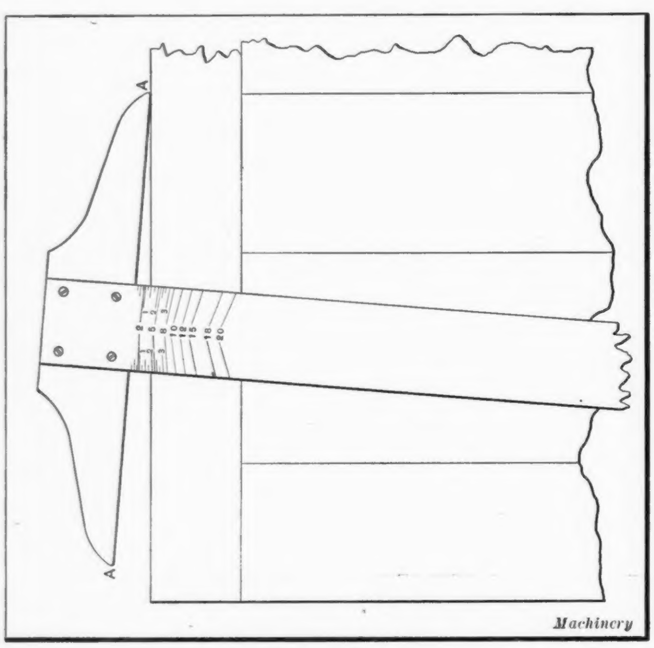
taken around the blank, the table was dropped so the blank would clear the cutter. The table was then offset a like amount in the direction *E* on the opposite side of the center, and the blank rotated in the direction of the arrow *G* to trim the opposite side of the tooth. The depth at which the gear-cutter was set was determined by experiment, as it depends on the amount the blank is set off center.

While this description may seem rather long and complicated, the process is simple and the settings are quickly made, and if a little care is exercised the work produced will equal that done by a regular sprocket cutter. If a record of the various settings is kept, it is possible to duplicate the work and make the settings very rapidly.

Brooklyn, N. Y. PHILIP H. KALLENBERG

HANDY T-SQUARE PROTRACTOR

In some lines of drafting a protractor is constantly required. The accompanying illustration shows one which is quite satisfactory in that it is always at hand, and is not conveniently "lendable." It is also sufficiently accurate if put on carefully. When used in combination with triangles, any desired angle can be obtained, either vertical or horizontal. The figures down the center of the blade and the lines running to them represent the angles, and the other figures and lines near the margin represent the tapers in inches and quarter inches per



Handy T-square Protractor

foot. The corners *A* of the head of the T-square should be rounded before the marks are put on, to avoid wearing and making the protractor inaccurate.

An accurate lay-out of the required angles and tapers is first made on drawing paper by the use of a good protractor or by trigonometry. Then while the lay-out is still fastened on the drawing-board, the T-square is set to the lines of the layout, and by means of a straightedge and a scratch-awl the angles and tapers are transferred to the blade, each mark coinciding with the edge of the drawing-board. After the marks are put on, the figures are stamped and inked.

Sarnia, Ontario, Canada. JOHN BURKAM

TOOLMAKER'S TEST INDICATOR

While there are a number of different styles of test indicators on the market, some of the best designs are in use only by the designers or their immediate acquaintances. The indicators shown in Fig. 1 at *A* and *B* were designed by Warren Dunbrack and have been used on the fine tool and die work at the factories of both the Waltham Watch Co. and the Howard Watch Works. The various points used on these instruments are contained in a boxwood holder shown at *D*.

While this indicator was designed for very small and accurate work, it can, of course, be used for any purpose for which

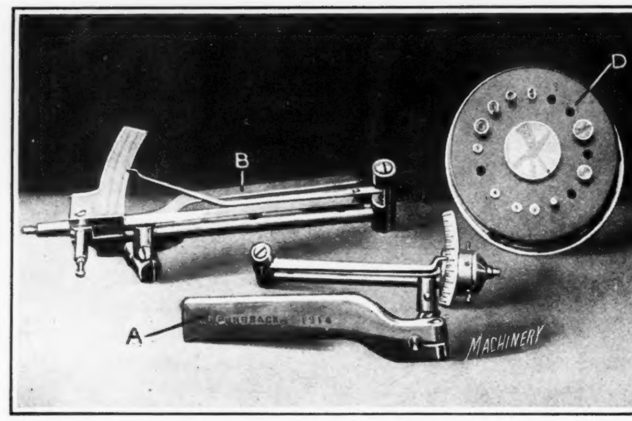


Fig. 1. Toolmaker's Test Indicators

an accurate indicator is adapted, but for average tool work an instrument of heavier construction is to be preferred, as it is stronger and more easily handled. Since the original was made, several others like it have been made, as well as some of twice the size, like that shown at *B* in Fig. 1, for heavier work. These indicators have all proved to be very satisfactory tools.

In the essential principle of multiplying levers, this indicator differs little from many others, but the construction which permits indicating a piece of work, both on its inside and outside diameters and also on its face without disturbing the setting of the tool, and the movable dial which allows its use in close corners, are well worth a description. The details, with the dimensions of the small sized tool, are given in Fig. 3, for the benefit of any who may wish to make up an indicator for personal use. For making the larger size it is only necessary to multiply the dimensions given by 2, except in the case of the pin which controls the multiplication of the levers. This is best placed farther away from the pivot so as to make the instrument less sensitive, as the extreme multiplication of levers is not needed on average work.

Referring to Fig. 2, *A* is the body of the tool, made in one piece from drill rod, *B* is the indicating dial segment, *C* the indicating pointer, and *D* the multiplying lever which swings on pivot *E* and carries the three indicating points *F*, *G*, and *H*. At *J* are shown two flat springs carried by a stud *K* which is a light drive fit in the body *A*. *L* is a screw having an eccentric pin turned on one end. This screw is used to adjust the normal position of the pointer *C* which is controlled by the pin *M* passing through it and the slot in the multiplying lever and between the two springs *J*. These springs are under constant tension, which keeps them in contact with the pin *M* and also with the eccentric pin on the end of screw *L*; so that turning the screw to the right or left will throw the pointer to either side of the dial, according to which side of a piece of work is being indicated when the full swing of the pointer is wanted in one direction. The pivot *P* which carries the

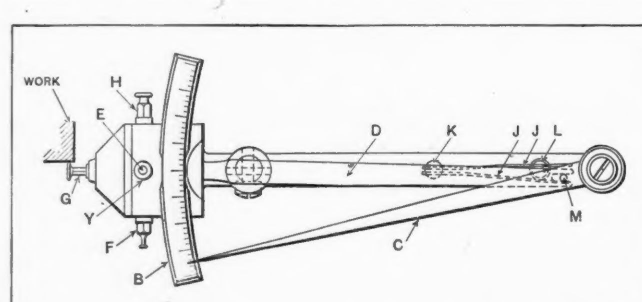


Fig. 2. Toolmaker's Test Indicator Assembled

pointer has a bearing in a bushing at one end and in a screw at the other, contained in the head *R*. The screw and bushing are made as shown in Fig. 3 at *Z* and *S*, respectively, being hardened and the edges nicely rounded over and given a high polish at the pivot bearing.

The head *R*, Fig. 2, is fastened securely to the body *A* by a pointed set-screw *T*. The dial *B* is a friction fit in the body of the tool, and to maintain this friction two cuts are made in the body as shown at *W*, the body afterward being hardened and drawn to a spring temper. *X* shows part of the holder which is merely a piece of drill rod bored out to slip on the body and then split and held to a proper friction fit by the screw shown. This, in combination with the holder *O* (see Fig. 3), allows the tool to be turned to any position when once set up in the lathe, and as all parts of the holder are a light friction fit there is little danger of the tool becoming damaged by an accidental blow or by undue pressure being applied to some part of it, as it would readily turn out of the way. Points of different kinds and sizes can be made up to suit different conditions, and as pressure may be brought to bear on either side of any of the three indicating points, there is hardly any position in which this indicator cannot be used.

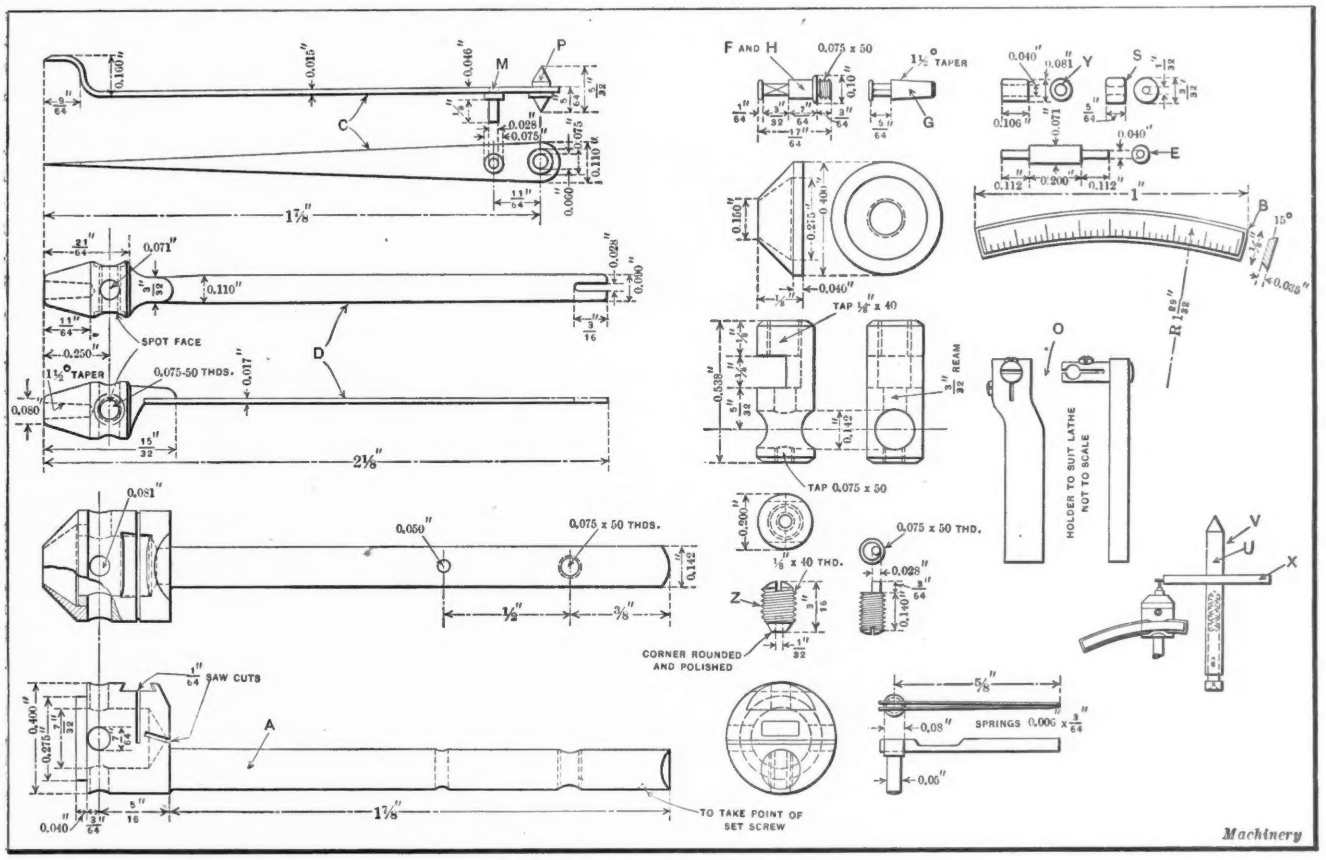


Fig. 3. Details of Toolmaker's Test Indicator

For indicating center-punch marks in a piece of work swung on the lathe faceplate or otherwise, a spring center *V* (Fig. 3) is used. This differs from the usual spring center in having a disk *X*, which is a friction fit on the body *U*. This disk permits the indicator to be placed parallel with the body instead of having to be swung around at an angle, which is sometimes necessary, thus throwing the tool out of adjustment so that an exact reading cannot be obtained from the indicator dial.

Long Island City, N. Y. DONALD BAKER

CARE OF THE EYES IN MECHANICAL WORK

There are a few points in connection with caring for the eyes of men engaged in mechanical work, which are of sufficient importance to warrant their being stated specifically. The man whose eyes are in first-class condition does not need glasses, of course; but one who has difficulty of any kind due to impaired eyesight, should always wear them. If the conditions of work are such that there are particles of emery or flying chips that might get in the eyes, glasses or goggles should be used as a protection.

If the eye becomes injured or a foreign body gets into it, it is not the part of wisdom to have a fellow workman attend to it, but it is far better to seek skilled aid at once. Many men who have some defect of vision neglect to secure suitable glasses on account of the bother of wearing them, or with the idea that they may outgrow the defect. It is undeniable that glasses are troublesome, but so are many things which we never think of doing without for that reason. The defects of vision that one outgrows or that tend to recover spontaneously are few in number. In the majority of cases the trouble either increases or the constant effort to see with impaired vision induces eye strain, with all its uncomfortable and sometimes serious consequences. It is far wiser to consult some reliable optician who may be recommended by your family physician, and get from him the lenses needed to correct your vision.

Some factories require the use of goggles, but even then many men foolishly omit this precaution. Let us suppose that a particle of steel or other foreign material enters a man's eye and he goes to a physician or to a skilled attendant in the hospital or first-aid room which many of the larger shops now provide for the care of injured employes. The foreign matter is extracted with a carefully sterilized instrument, and possibly a little mild antiseptic solution is dropped into the eye. These precautions make it certain that no infectious matter is carried into the eye by the instrument, and that anything of this kind accompanying the particle is rendered harmless.

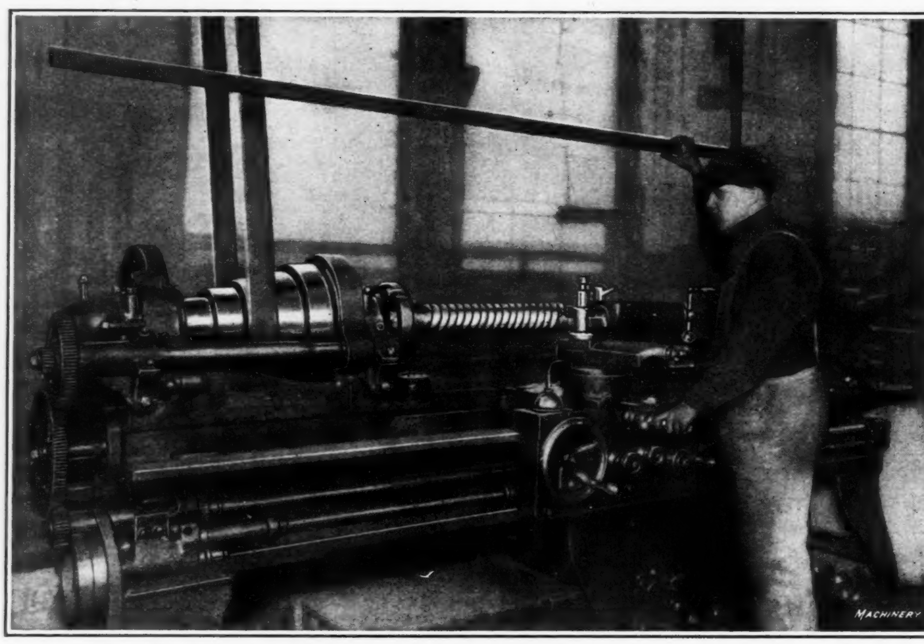
On the other hand, if a fellow shopman is called upon to remove the steel, emery or other matter, the chances are that he will whittle a bit of wood to a point with the same knife with which he cleans his finger nails and cuts his tobacco, not infrequently moistening with saliva the tool thus made. It is true that even this rude instrument may not affect the delicate covering of the eye ball, and yet there are frequent cases when it does so. I might quote startling statistics showing the average number of hours' work lost by the man whose eye has been infected by "toothpick treatment," but this is probably unnecessary, as everyone today knows something of the wonderful results in general surgery of antiseptic treatment and

can readily see the need of giving every possible chance to so delicate an organ as the eye.

In writing this article I wish to be understood as casting no aspersions on the skill of the man in the shop who enjoys the well-earned reputation as an extractor of chips from his friends' eyes. I have known more than one such man to whose manipulation I would submit my own eye with as much confidence as to any occulist *if the workman's instruments and hands were properly sterilized.* ANONYMOUS

LATHE EQUIPPED FOR HEAVY SCREW CUTTING

The Zeh & Hahnemann Co., Newark, N. J., uses Colonial "Red Star" steel for the screws used in its percussion type of power presses. These screws are cut on a lathe as shown in the accompanying illustration, and owing to the severe nature of this work a great deal of trouble was experienced through the breaking of teeth on the first pinion of the change-gears used to transmit motion to the feed-screw. To overcome this difficulty the lathe on which this work is done was equipped with a special drive shown in the illustration, which makes connection with the change-gears by means of a shaft extending across the front of the headstock. At the right-hand end of this shaft there is a pinion which meshes with the back-gear in front of the headstock, the teeth of which are of coarser pitch than those of the change-gears, and by having the pinion mesh with them, sufficient strength is provided to avoid trouble from breakage. At the left-hand end of this shaft connection is made with the change-gears, and as the gear at this point is of considerable size, the strain on the gear teeth is sufficiently reduced to avoid trouble from broken gears. Equipped in this way the lathe has been giving very satisfactory service without any of the trouble formerly experienced. E. K. H.



Lathe equipped for cutting Screws for Zeh & Hahnemann Percussion Power Presses

MAGNIFYING EYEGLASSES

Those whose work necessitates the use of a magnifying eyeglass, such as the familiar rubber-mounted glass, often known by its French name "loupe," are sadly aware of its most exasperating characteristic—the tendency of the inner surface of the lens to become clouded by moisture at the exact instant when unobscured vision is most needed. Various expedients have been tried to overcome this difficulty. Some persons have smeared the lens with glycerine, but it is doubtful if anyone did this more than once or twice. Some drill holes for ventilation in the rubber, which answers fairly well if the holes are sufficiently large and numerous.

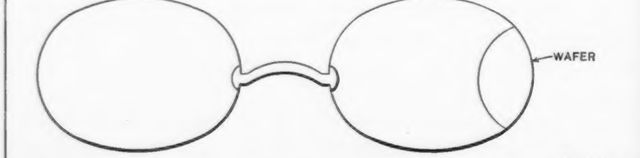


Fig. 1. Spectacles with Magnifying Wafer

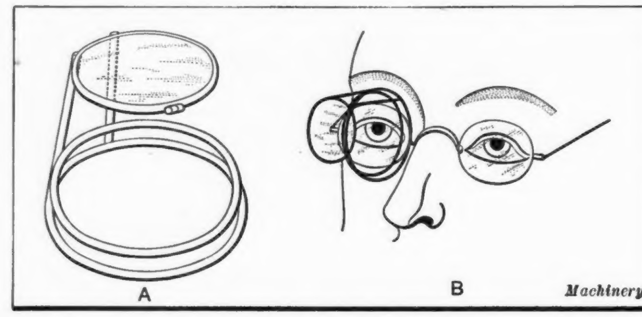
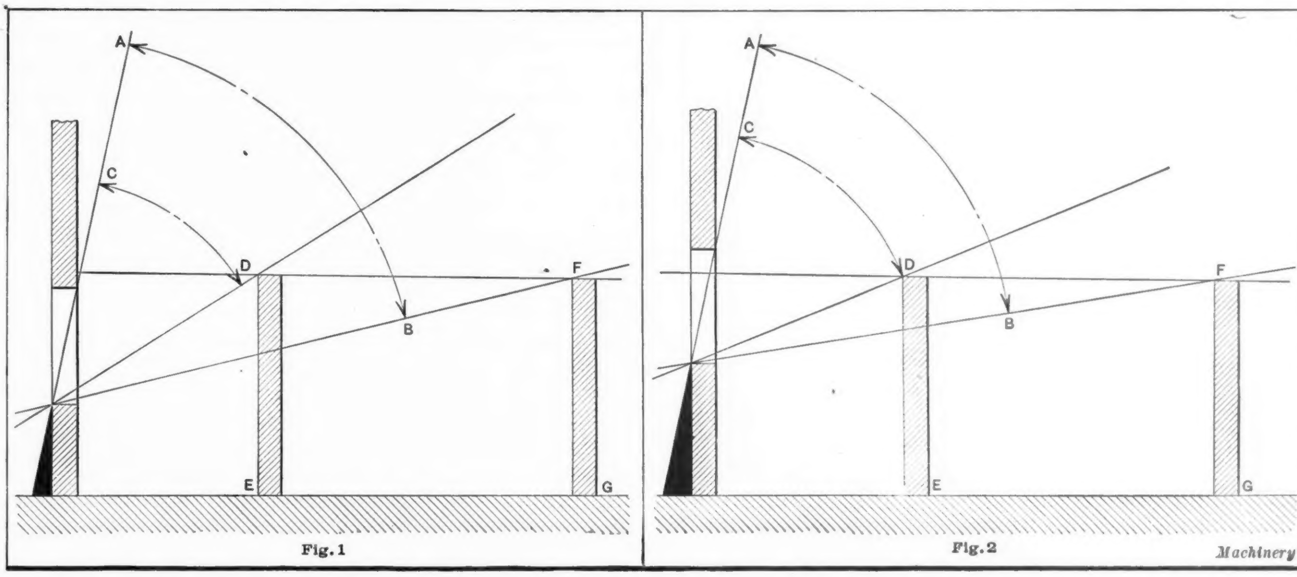


Fig. 2. Skeleton Loupes

Prominent among the memories of former days is that of a toolmaking friend who proudly wore an unsteamable glass of his own devising and construction. Its body was of No. 18 brass spring wire formed into a frustum of a cone by winding it around a taper-shank drill socket. To its base he attached a ring to be grasped by the muscles about the eye, and at its other end was placed a ring that encircled the lens. It was a success as far as non-steaming qualities went, but its weight compelled him to twist his face into a hideous shape, and the relaxation of the facial muscles caused by a moment's forgetfulness would send the glass careering along the floor, hotly pursued by its owner. He later cured the device of its wanderlust by tying to it a piece of stout twine, the other end of which he fastened to the shoulder strap of his apron.

Those who have normal eyesight can use a spectacle or "nose pincher" frame, one side of which is empty while the other carries a lens of four or five inches focal length. This is a very convenient arrangement, but manifestly unsuited to one who has to wear glasses for defective vision. These people have troubles of their own. Some of them use what the optical trade calls a "grab front"; that is, a frame holding a lens and having two prongs by which it is attached to the wearer's spectacles. Others mill or file a slot in the mounting of the ordinary loupe so that it can be hung on their glasses. They usually add a pair of small springs after a few loupes have fallen off and been broken. Still others have a "wafer," like those in bifocal glasses, cemented to the inner surface of one spectacle lens near its outer margin, as shown in Fig. 1, but this plan has the objection that it is possible to look through the wafer only by going through great contortions.

One man brought to the shop a contrivance which he confidently regarded as the acme of perfection. The lens was carried by a hinged arm attached by a ball-and-socket joint to a strap encircling the forehead, like the mirror with which the physician reflects light into a man's mouth when he desires to inspect the "department of the interior." This was very convenient, as the lens could be brought down to the line of vision when required and turned up above the front of the head when not in use. One of his shopmates, foreseeing the



Figs. 1 and 2. Diagrams showing Relative Conditions of Illumination obtained with Windows placed near Floor and Higher up in Wall

inevitable, advised the others to offer no criticisms, but patiently await results. One day, as summer advanced and the sun shone brightly on the bench where the proud owner of the "doodad" was at work, its genial rays were brought to a focus by the lens and ignited his hair. He worked placidly on, merely expressing wonder that some folks smoked such malodorous tobacco, until the process of combustion reached his scalp. Then a swift motion of his right arm sent the once fondly cherished "doodad" flying through the open window.

The writer does not know who devised the arrangement shown at *A*, Fig. 2. Though designed to hang on one's glasses, as at *B*, it can be held equally well in the usual manner. It is called a skeleton loupe and may be had in focal lengths from one to four inches from any watchmaker, as all wholesale jewelry houses have them in stock.

New London, N. H. GUY H. GARDNER

HEIGHT OF WINDOWS FROM FLOOR

Fig. 1 shows the conditions of illumination when a window is placed near the floor, and Fig. 2 shows the conditions when a window of the same size is placed at a greater height from the floor. In each case arc *AB* represents the total direct illumination which can come through the window; and *DE* and *FG* in each diagram represent walls of the same height which cut off a certain amount of light. It will be apparent that with a window placed high up the amount of light obstructed by both the nearby and the distant wall is less than where the window is placed near the floor. These diagrams also illustrate a fact which should be quite apparent, namely, that a nearby wall cuts off more light than one at some distance from the window.

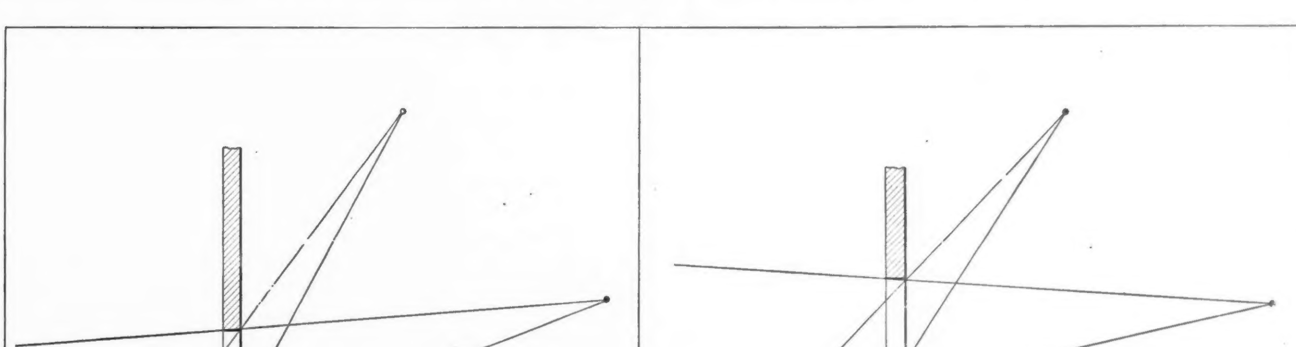
In placing windows in a factory building it naturally makes a great deal of difference where the light is needed. Thus, in Figs. 3 and 4, with unobstructed windows, we see that windows placed near the floor favor illumination on benches, etc., that are near the wall, while windows at a greater height from the floor give poor illumination at points near the wall, but improve the general illumination throughout the shop. In Figs. 3 and 4 the single cross-hatched areas obtain direct light from the sun during only a portion of the day, and the double cross-hatched areas never obtain direct illumination.

New York City. ROBERT GRIMSHAW

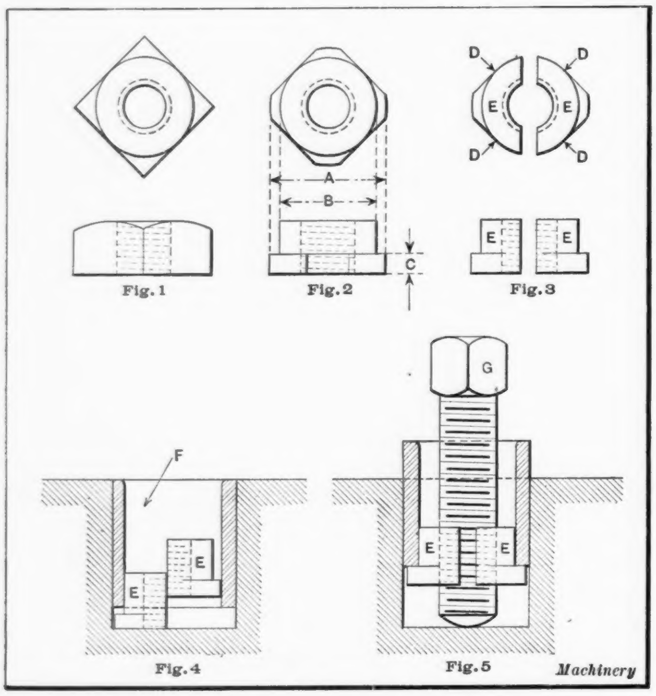
While the above deductions are correct, modern practice in factory construction favors the use of an abundance of windows extending for almost the height of the room, so that advantage is taken of the full amount of natural illumination which is available at any time of the day.—EDITOR

EXTRACTING A HARDENED BUSHING FROM A FIXTURE

Recently it was found necessary to extract a hardened bushing from a fixture, and, as there was no way of driving it from the back, the work was accomplished by using a common square nut and a cap-screw. The nut, shown in Fig. 1, was a little larger across diagonal corners than the diameter of the hole into which the bushing was driven. It was first turned down so that its diameter *A*, Fig. 2, was a little less than the



Figs. 3 and 4. Positions receiving Direct Light All Day, during Part of Day and at No Time with Low and High Windows



Method of extracting Rings or Bushings from Holes

outside diameter of the bushing. Then a part was turned down to the diameter *B* of the hole in the bushing. The thickness *C* of the lip thus formed was such that the lip could pass beneath the bushing, as shown in Fig. 4. The nut was cut in two by a tool that was a little wider than the width of one of the lips *C* and the two opposite lips were filed flush with the smaller part, as shown at *D* in Fig. 3. Both halves *E* were then placed in the bushing *F*, Fig. 4, and the insertion of a cap-screw *G*, Fig. 5, spread the halves of the nut apart, causing the lips to catch under the bushing; as the screw was turned, the bushing was forced out of the hole.

Troy, N. Y. A. M. Aldrich

DIEMAKER'S KINK

The device illustrated at *X* in Fig. 1 is a valuable addition to a diemaker's kit. It is used for locating the piercing holes in die-blocks and for locating the piercing plungers in the punch pad; it will also be found especially useful on that class of dies known as pillar sub-press dies, shown in outline at *Y*. The tool *X* consists of the body *A* made of hardened tool steel, in which a center hole is lapped, the bottom *B* and edge *C* being ground true and square with the hole. *E* is a hardened and ground pin, the ends of which must be ground true with the body and which should have an included angle of about 60 degrees. This pin should be an easy sliding fit in the body of the tool. To use the device for locating the centers of piercing holes in die-blocks, templets or other work, it is placed on the work, lightly clamped in the approximate position of the hole and then adjusted accurately by the use of a micrometer depth gage or other measuring tool of suitable nature, as indicated in Fig. 2. After being located in position, the center pin is put in place with the sharp pointed end down and lightly tapped with a hammer on the top to make a center in the work, which can afterward be used as a locating point.

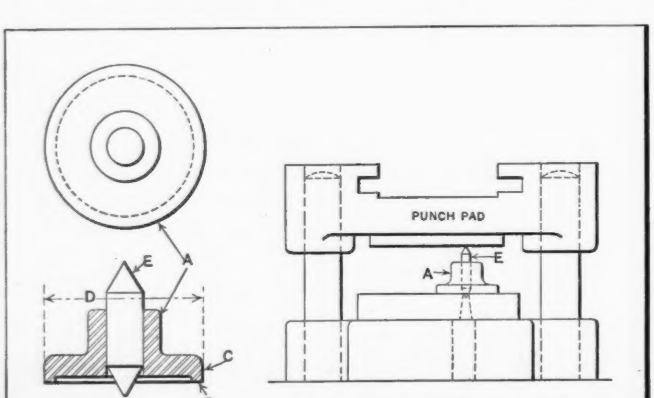


Fig. 1. (X) Centering Plug for transferring Holes; (Y) Application of Plug to a Punch and Die Job

A convenient form of parallel clamp for use with this tool is illustrated in Fig. 2. One end is forked to fit over the shoulder on the body of the tool, while the screws *K* for adjusting the clamps are placed well back from this end to allow plenty of room for the work to enter the clamp when center locations are some distance from the edge of the work. In locating centers for the piercing punches in the punch pad, the die and punch pad are first put in place in the sub-press or holder; then the tool is located in position over the piercing hole in the die by entering the center pin into the piercing hole, as shown at *Y* in Fig. 1. This method obviously locates the tool exactly central with the hole, as the tapered sides of the pin are self-centering, and the body of the tool, resting on the die face, holds the center pin square with it; it is only necessary then to lower the punch pad until it rests on the center pin, which will make a sufficient impression on the punch pad from which to work. Care must be taken, however, to see that the force used is not so great as to cause the hardened pin to damage the edges of the piercing hole in the die. This might easily occur if the punch pad and its holder were allowed to drop onto the pin. If anything more than a light impression is desired, the best method is to let the punch pad down until it just holds the pin in place and then, working from the back of the die, a rod can be placed against the opposite end of the pin through the die clearance hole, after which a light tap of the hammer will do the work.

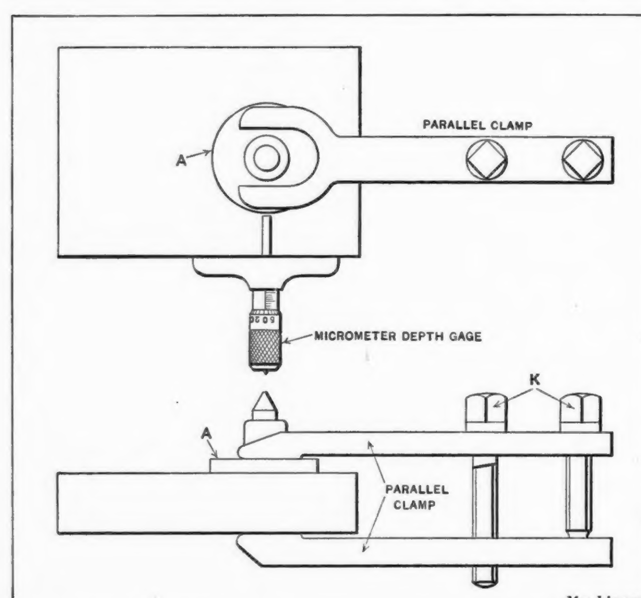


Fig. 2. Method of locating Hole by Use of Centering Plug, Parallel Clamp and Depth Gage

In making this tool, the body was first roughed out on the lathe, the center hole being reamed; it was hardened and then the hole was lapped out, after which it was ready to be ground on the face and diameter. To make sure that all the parts were square and accurate, we first took a piece of drill rod and placed it in the bench lathe chuck in which it was turned to within 0.002 of 3/8 inch; then it was finished by grinding until we could just wring the body onto it. In this position the body was ground, first on the bottom and then on the diameter, the diameter *D* being ground so that the dimensions came in even figures, in this case 1.500 inch, for ease in figuring when setting to given centers with the aid of micrometers. In making the center plug, a piece of drill rod was used with the ends turned to 60 degrees, after which the parts were hardened and tempered and the body lapped until it was a snug fit in the part *A*. Then with the plug in place in *A*, with one end projecting, it was strapped in placed on the faceplate of a bench lathe and the body *A* indicated until it ran true, after which the ends were ground, using the bench lathe

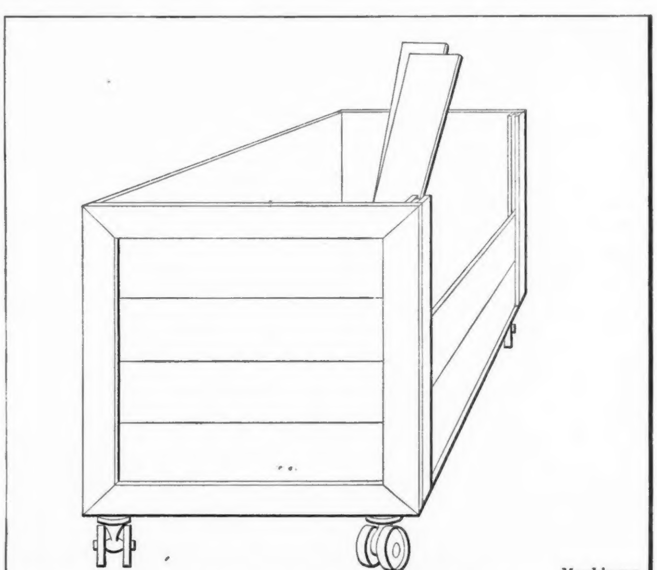
grinder. The other end was finished in a similar manner, but the extreme end or point was blunted off slightly so that a light hammer could be used on it when occasion required. After the ends were finished in the manner described, the pin was removed from the body and the outside lapped until it became an easy sliding fit on the body. The tool was then ready for use, and has been found most convenient.

Long Island City, N. Y. DONALD BAKER

BOX TRUCK

In the accompanying illustration is shown a box truck which is being adopted in many factories for transporting work step by step. This truck is easily made, light and durable, and allows of much faster work by machine operators; it is also a potent factor in the "safety first" movement, and does away with the necessity of looking here and there for boxes and barrels to put the work in, which are generally driven full of nails, wire and ragged-edged tin binders.

This box is made of 3/4-inch pine or other cheap lumber, planed on both sides, with a six-inch caster wheel at each corner; the boards on one side are removable, allowing the operator to reach the work conveniently when the box is not full. When necessity requires, these trucks can be picked up by the crane and stacked one on another in tiers. They are easily moved about the room even when heavily loaded. The illustration really needs no explanation, as manufacturers can quickly see its advantage over the box, barrel and pan system of transportation.



Box Truck for carrying Loose Material and Small Parts

Pittsfield, Mass. G. R. SMITH

TOOL FOR RE-CENTERING AXLES

For use in re-centering axles I developed the tool shown in the accompanying illustrations, which enables this work to be done much more rapidly than by other methods in common use. Fig. 2 shows the tool in operation, and in Fig. 1 the cutting tool is illustrated and an enlarged view is shown of the point of the tool in order to give a clear idea of its form. It will be evident from the latter illustration that this tool drills the center out to a greater depth and countersinks it at a single operation; also, that the shank of the tool is made to fit an air motor by which it is driven.

The entire tool is supported by a clamp *A*, Fig. 2, which is secured to the axle journal; and this clamp is slightly rounded on the under side in order to have it fit properly on the work. The clamp is held in place by ¾-inch bolts, and proper location of the feed-screw on the air motor is obtained by lining up the tool with the axle by means of a square *B*. By the use of this tool it is much easier to re-center an axle than to lift it up on a horizontal boring mill or drill press, where it is frequently necessary to center one end and then turn the axle around to center the opposite end; and when the condition of the axles is such that about half of them have to be re-centered before they can be set up on the lathe, this tool is the means of saving a great deal of time. M. K.

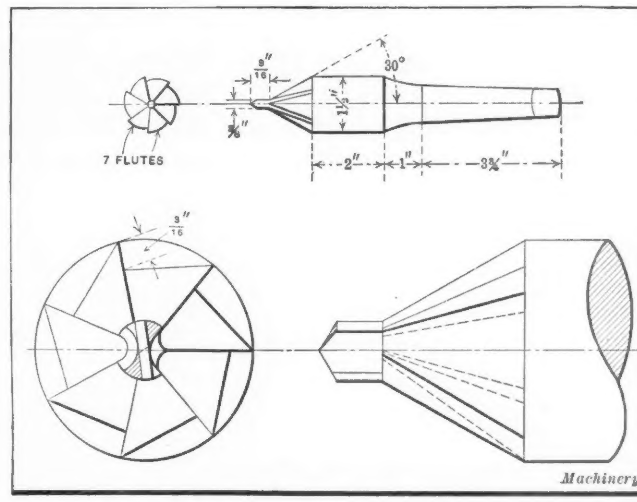


Fig. 1. Close View of Re-centering Tool and Enlarged View of Point

FLOOR PLANS IN MACHINE CATALOGUES

A large manufacturing plant had a serious fire, and while most of the machines and equipment were destroyed, some were saved or repaired and placed in another building until the damaged buildings could be reconstructed. As all the plant lay-outs, drawings, etc., were destroyed, it was necessary to get out entirely new sets of floor plans, speed charts, etc. This was some work, for before any information could be obtained from the manufacturer, it was necessary to find where and when a machine was bought, its size, and its serial number, which was stamped in different places on different makes of machines.

This work would have been much easier if the machine tools and equipment were designated as are automobiles; for instance, Blank & Co. 16-inch engine lathe, "1906 Model," or Blank & Co. 16-inch engine lathe, "Model H." Then if the catalogue showing "Model H" contained a floor plan drawn to small scale, but giving all such data as feeds, speeds, sizes of pulleys, horsepower required, etc., that would be useful when moving the equipment, it would be of much more value than a catalogue containing the tables, etc., that are usually found therein.

South Orange, N. J. WILLIAM PHILIP

* * *

The United States Civil Service Commission will hold examinations November 14 for an electrical and mechanical engineer to fill a position in the Bureau of Yards and Docks, Navy Department, Washington, D. C., at $12.48 per day. The duties of the position cover the expert maintenance and supervision of the operation of all navy yard power plants, embracing the economical production, distribution and utilization of electric power for manufacturing, pumping dry docks, charging submarines, for ships undergoing repairs; compressed air for manufacturing; steam for power and central heating, etc. Technical education will have a weight of forty points and experience and fitness of sixty points.

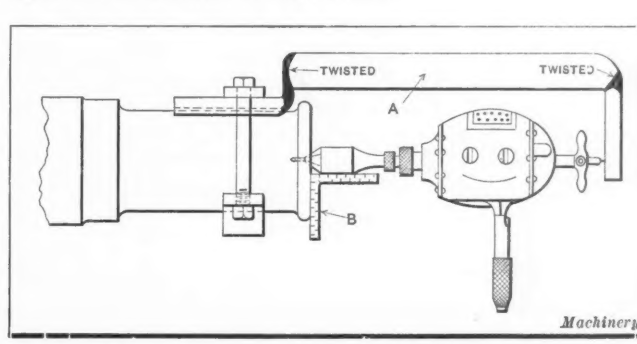


Fig. 2. Air-operated Tool for Use in re-centering Axles

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

WEIGHT OF THE GRAIN

A. C. G.—Will you kindly advise whether or not the unit of the grain is the same in apothecary as in avoirdupois weight?

A.—The grain was originally the weight of a plump kernel of wheat, and is the same in apothecary, avoirdupois and troy weights.

FORM OR FORMED MILLING CUTTER

G. T. Co.—Which is the preferable usage, "form" milling cutter or "formed" milling cutter?

A.—The consensus of opinion seems to favor "form" milling cutter, the reason being that the cutter is generally referred to with its product in mind, the same as a gear-cutter. Strictly speaking, the usage should depend upon whether the characteristic of the cutter itself is meant or that of its product, but in order to avoid confusion authorities seem to have agreed to use "form" instead of "formed."

PROBLEM IN ALGEBRA

J. G. K.—Given the two simultaneous equations, $x^2 + y = 7$, and $x + y^2 = 5$, can the values of x and y be found without solving an equation of a degree higher than the second?

A.—We do not know of any way of finding x and y without solving an equation of the fourth degree. The method used by the writer would be to find the value of x in the second equation, substitute it in the first equation, thus obtaining $y^4 - 10y^2 + y + 18 = 0$; solving this by Horner's method, $y = 1.6384 +$. Then $x = 5 - 1.6384^2 = 2.3157$. J. J.

ANNEALING GERMAN SILVER CUPS

P. J. Y.—I have been having trouble with "ten per cent" German silver drawn into cup shape and then redrawn. We undertook to anneal the cups in a Stewart muffle gas furnace, but the sides cracked. We have tried placing the cups in all positions and have mauled the sides before placing them in the furnace, but they always crack before they get black. The size of the cup is 6 inches diameter at the bottom, and the height of the sides is 2½ inches. The temperature of the furnace is kept between 1100 and 1300 degrees F. What is the proper temperature for annealing German silver, and what formula produces a German silver best suited for drawing purposes?

The questions are submitted to readers who have had experience in working German silver.

ANNEALING HARD CASTINGS

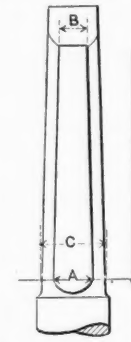
P. J. McK.—I would like to know of any methods that we could use to drill hard cast iron. We have tried drilling with turpentine as a lubricant, but without results, and have also tried heating the castings to a dark red, allowing them to cool in a dying fire.

A.—The best advice we can give you in regard to the treatment of hard castings is to throw them into the scrap heap. Usually the time and trouble taken to save a hard casting costs more than a new one. However, it is often possible to anneal hard castings so that they may be easily machined. Heat the castings to a temperature of 1500 to 1600 degrees F., pack in an iron box filled with air-slaked lime and let cool slowly. The time required for cooling will vary from twenty-four to forty-eight hours, depending on the size and mass of the castings. Sometimes very hard castings may be drilled successfully with a forged flat drill, using turpentine as a lubricant. The speed should be slow—not more than eight or ten feet peripheral speed per minute.

"USE-EM-UP" DRILL SOCKET DIMENSIONS

W. L. M.—Will you kindly give me the dimensions of the "Use-em-up" drill sockets? That is, the type with a flat milled on the side of the shank and with the socket made to fit.

A.—The dimensions of "Use-em-up" drill sockets made by the American Specialty Co. of Chicago, Ill., are given in the accompanying table for Nos. 1 to 5, inclusive. The data are given in terms of width of flat at the large and small ends, and the diameter of the shank at the large end where dimension A is measured. It should be understood that the flat is milled parallel to the axis of the drill. When the cutter has been sunk at A to give the required width of flat the width B is bound to be right, provided the taper of the shank is correct, and the index centers are set for parallel work.



NO. OF DRILL SHANK	WIDTH OF FLAT A	WIDTH OF FLAT B	DIAMETER C
1	9/32	7/32	0.475
2	15/32	3/8	0.700
3	5/8	1/2	0.938
4	3/4	5/8	1.231
5	15/16	27/32	1.748

SLEEVE FITS TO THIS LINE AND C = DIAMETER AT LIMIT

Machinery

Dimensions of "Use-em-up" Drill Sockets of Five Sizes

ODD OR EVEN REAMER FLUTING

P. J. V.—Kindly advise me whether or not it is a fact that odd lipped tools such as reamers of, say, five, seven or nine flutes, make smoother and truer finishes than those with six, eight or ten flutes. One of my toolmakers maintains that odd lipped tools of, say, five to seven cutting edges produce the best finishes, but I maintain that when the stock to be removed is not excessive and when a six-flute reamer does not give the desired smoothness of cut, then one of double the number of flutes, or more if necessary, will do the work, in all cases keeping an even number of flutes for grinding and measuring purposes. If odd lipped tools are superior, why are they?

A.—It is undoubtedly true that an odd number of teeth in a reamer favors smoother work than an even number. The reason for this is as follows: In a reamer having an even number of teeth, any ridge or hard spot in the work tends to push the tooth away at that point and the action is transmitted diametrically across the reamer to the opposite side of the hole. Now, if the reamer has an odd number of teeth the effect is transmitted across the hole to two teeth instead of one and is, therefore, less than if concentrated on one tooth. In other words, the irregularities are not see-sawed back and forth across the hole by the action of the teeth as much with an uneven number of teeth as with an even number. The average manufacturer, however, prefers reamers with an even number of teeth because of the difficulty of measuring those with an odd number of teeth. Reamers which have an even number of teeth, but in which the spacing is broken up so that it is irregular, can be made to ream a hole as true as an odd-toothed reamer. The difficulties met with in grinding can be overcome by applying a method like that shown in the April number of MACHINERY on page 694, under the heading, "Calipering Five-Flute Reamers."

POSITIVE CHARACTERISTICS OF LOGARITHMS

C. P. W.—Why do tables giving the logarithms of trigonometric functions always print 8 or 9 for the characteristics of the functions, with the exception of the cotangents, secants, and cosecants?

A.—When logarithms were first invented (about 1614), they were applied to the trigonometric functions. Computers at that time were rather shy about using negative numbers, and to avoid these, 10 was added to the negative characteristics, thus making them positive for practically every case that would ordinarily arise. The tables first computed contained many errors, which were gradually eliminated by the publica-

tion of other tables based on the first set, and which copied the preceding ones closely. This practice (together with a slightly increased difficulty in setting up negative characteristics) probably accounts for the present appearance of most tables. In many of the tables and textbooks, positive characteristics are used even in ordinary logarithmic computation, when decimals are involved, although in most American works, they are used only in connection with trigonometric functions. The practice of adding 10 (or even 20, in some cases) is very awkward and clumsy, and is one that the writer does not recommend. The writer (in common with many authors and computers) always changes the positive characteristic to its negative equivalent before using the logarithm. There are a few tables in which negative characteristics are printed in connection with the logarithms of the trigonometric functions, and it is to be hoped that this practice will become universal. It may be remarked that the negative characteristic can always be found by subtracting the positive characteristic from 10; thus, log sin 1 degree, 20 minutes $= 8.36689 = \bar{2}.36689$. Since the cotangents of angles less than 45 degrees and the secants and cosecants of all angles are greater than 1, the characteristics of the logarithms of these functions are positive or are 0. J. J.

ILLUSTRATION OF THE FIRST LAW OF MOTION

T. M. Y.—Referring to the illustration, which represents a wagon, suppose a cord to be attached to one of the wheel spokes at *A*; a pull on the cord will make the wagon move in the direction indicated by the arrow. Suppose, however, the cord had been attached to one of the lower spokes at *B* and pulled in the direction indicated by the arrow; in what direction would the wagon move, and why?

A.—The wagon will move in the same direction in either case; that is, in the direction of the pull. It is rather surprising, when the experiment is tried with a bicycle or wagon and the cord is attached as shown at *B*, to see the end of the cord at *B* apparently moving backward instead of forward, as most persons expect it to do. This is a good example of the correctness of the first law of motion, which may be stated as follows: Every body continues in a state of rest or of uniform motion in a straight line, unless acted upon by some external force that compels a change. Note particularly that the acting force must be external. In this case, the pull is an external force; hence, if it is sufficiently great to overcome the resistance to motion, the wagon must move, and (in accordance with the second law of motion) it must move in the direction in which the force acts. Consequently, it makes no difference where the cord is attached, whether to the hub, the rim, a spoke, or to the wagon body, the wagon must move in the direction of the pull. Moreover, the end *B* of the cord does not move backward. It appears to move backward on account of its circular motion; but, if the end *P* moves six inches the end *B* will also move six inches in the same direction, provided the cord is not stretched. In the case of a locomotive, the force exerted by the steam is an internal force, so that there is apparently a violation of the first law of motion. However, it will be noted that the only reason that a locomotive moves is because of the friction between the drivers and the rails. If there is not sufficient friction, the wheels will simply revolve and the locomotive will remain stationary. J. J.

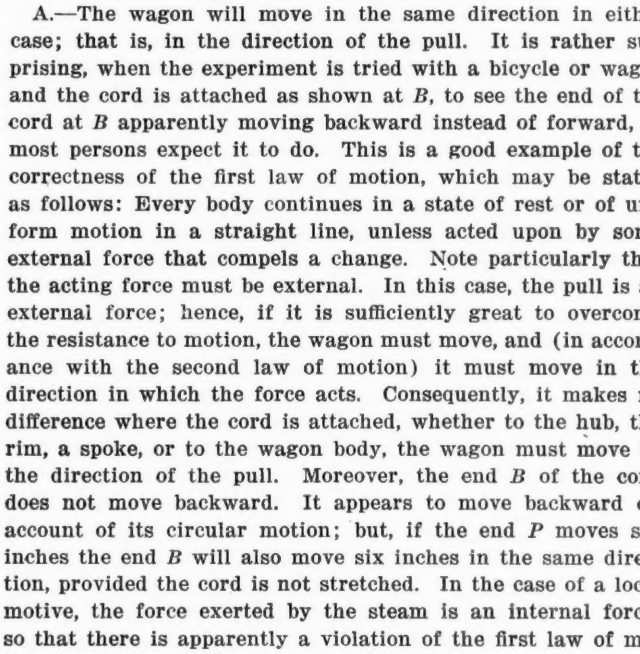
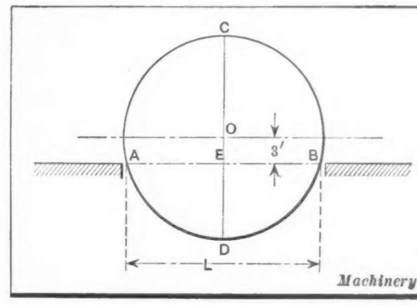


Diagram illustrating First Law of Motion

LENGTH OF HOLE IN FLOOR FOR FLYWHEEL

C. A. F.—A flywheel is 16 feet in diameter (outside measurement) and the center of its shaft is 3 feet above the floor; how long must the hole in the floor be to let the flywheel turn? Please show how this may be found.



Method of finding Length of Hole in Floor for a Flywheel

A.—The conditions are as represented in the illustration. The line *AB* is the floor level and is a chord of the arc *ADB*; it is parallel to the horizontal diameter through the center *O*. *CD* is a vertical diameter and is perpendicular to *AB*. It is shown in geometry that the diameter *CD* bisects the chord *AB* at the point of intersection *E*. Now, one of the most useful theorems of geometry is that when a diameter bisects a chord, the product of the two parts of the diameter is equal to the square of one-half the chord; in other words, $AE^2 = ED \times EC$. If *AB* is represented by *L* and *OE* by *a*, $ED = r - a$ and $EC = r + a$, in which $r =$ the radius *OC*; hence, $\left(\frac{L}{2}\right)^2 = (r - a)\,(r + a) = r^2 - a^2$, and $L = 2\sqrt{r^2 - a^2}$. Substituting the values given, $L = 2\sqrt{8^2 - 3^2} = 14.8324$ feet $= 14$ feet, 10 inches. The length of the hole should be at least 15 feet, to allow for clearance. J. J.

EXPRESSING ANGLES IN CIRCULAR MEASURE

P. P. C.—Please explain what is meant by the term "radian" and why angles are sometimes measured with this unit instead of in degrees, minutes, and seconds.

A.—In geometry, the measuring unit for angles is the right angle; in practical trigonometry, angles are measured in degrees, minutes, and seconds; in what is called analytical trigonometry, the measuring unit is the radian. The first two of these measures are concerned only with the angle itself or with a part of a revolution; as a consequence, no linear unit can be used in comparing one angle with another, and both measures are called angular measures. In certain formulas and in mathematical investigations, it is advisable to have a linear measure for comparing or denoting angles, and in such cases the arc is used instead of the angle. Now, a semicircle of a radius *r* has a length equal to πr; but since this line is rather long to use as a unit of arc measurements, it is customary to use that part of the semicircle which is equal in length to the radius. It will readily be perceived that the angle which this arc subtends is constant; in other words, the angle will be the same whatever the radius. The value of this angle in angular measure is readily found. Thus, since the semicircumference subtends two right angles, or 180 degrees, and its length is πr, we have the proportion $\frac{180}{\pi r} = \frac{x}{r}$, from which $x = 57.29577951 +$ degrees $= 57$ degrees, 17 minutes, 44.8 seconds, very nearly. Hence, if an angle is given in degrees, minutes, and seconds and it is desired to find its value in radians, reduce the minutes and seconds to a decimal of a degree, and divide the angle by 57.29578 or multiply it by $\frac{\pi}{180} = 0.0174532925 +$. As an example showing the use of circular measure in a formula, the area of a sector is equal to the product of one-half the arc by the radius; if the central angle is *V* radians, the length of the arc is rV; the area of the sector is $A = \frac{1}{2} rV \times r = \frac{1}{2} r^2 V$. By substituting $v = \frac{1}{2} V$, $A = r^2 v$, a very convenient and simple form. When angular measure is used, $A = 0.0174532925 + r^2 v$, when *v* is in degrees. J. J.

DRAWING A CIRCULAR ARC THROUGH TWO GIVEN POINTS

T. S. B.—Will you please show me how to draw a circular arc through two given points when the radius of the arc is known and the center falls without the drawing?

A.—There are a number of ways in which this may be done, but the writer prefers the following construction. Let A and B be the given points and let r be the given radius. Calculate the height CH of the arc, using the formula $h = r - \sqrt{r^2 - c^2}$, in which r = the radius and c = one-half the distance between the two points, or AC in the illustration. Draw AB and bisect

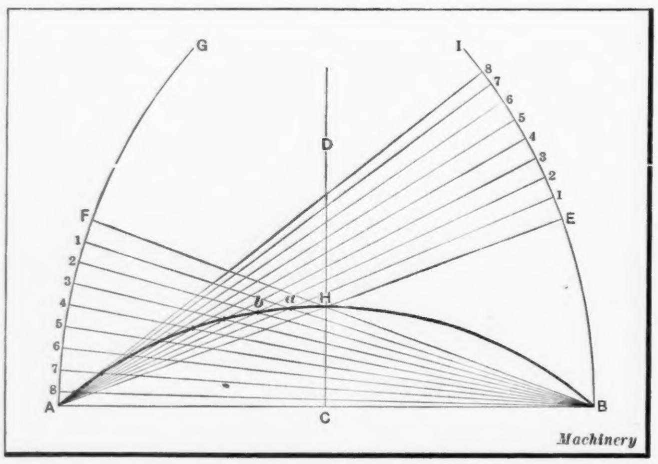


Diagram showing how Circular Arc may be drawn through Two Given Points

it at C; draw the perpendicular CD and lay off $CH = h$. With A and B as centers and a radius equal to AB, describe the arcs BI and AG. Draw AHE and BHF, intersecting the arcs BI and AG in E and F, respectively. Using the spacing dividers, lay off $F1$ toward A and its equal $E1$ toward I; draw $A1$ and $B1$, and mark the point of intersection a. Lay off $F2$ and $E2$, draw $A2$ and $B2$, and mark the point of intersection b. Proceed in this manner until a sufficient number of points have been located; these points are all situated on the required arc, which may be drawn through the points by means of an irregular or adjustable curve. The distances F-1, 1-2, 2-3, etc., may be equal or unequal, but the corresponding arcs on AG and BI must be equal; for example, $E5$ must equal $F5$, etc.

J. J.

DISCHARGE OF WATER THROUGH PIPE

A. C. T.—About one-half mile from our shop is a large spring; we wish to tap this spring and lead the water to the shop through a 1½-inch pipe; how many gallons of water per minute will be obtained? The difference of level between the spring and the tank is about 60 feet.

A.—There are many formulas for calculating the discharge of water through a pipe; some of them are quite complicated, and all are, and must of necessity be, approximate. It is impossible to derive a formula that will fit any case. The pipe, or conduit, is made of various materials, and the friction of the moving water varies greatly with the material of which the pipe is composed. Even for a particular material, the discharge will not be the same for a pipe that has been in use a long while as for a new pipe. The impurities carried by the water stick to the pipe, causing it to become foul; this reduces the diameter and discharge, and also alters the resistance due to friction. If the slope is not gradual and even, air will accumulate at different points; this also reduces the discharge, since the area of the cross-section at those points is less. Bends, especially those of short radius, reduce the velocity and, consequently, the discharge. Contractions and enlargements, likewise, exert a deterrent effect. As a result of the examination and comparison of a large number of experiments, the following formula has been derived; it is simple in form, is said to give good results, and is admirably adapted to logarithmic computation: $v = 0.0757cd^{\frac{2}{3}}\left(\frac{h}{l}\right)^{\frac{1}{2}}$, in which v = velocity, in feet per second; d = diameter of pipe, in inches; h = head, in feet; l = length of pipe, in feet; and c = a constant the value of which depends on the material of which the pipe is composed. For new, smooth, wrought-iron pipe, laid straight and without bends, c may be taken as 160. Since the actual internal diameter of a 1½-inch pipe is 1.61 inch, the velocity of discharge in the pipe is

$$v = 0.0757 \times 160 \times 1.61^{\frac{2}{3}} \times \left(\frac{60}{2640}\right)^{\frac{1}{2}} = 2.508 \text{ feet per second.}$$

The number of cubic feet per minute discharged is

$$\frac{60 \times 2.508 \times 0.7854 \times 1.61^2}{144} = 2.127; \quad 2.127 \times 7.48 = 16 \text{ gallons}$$

per minute.

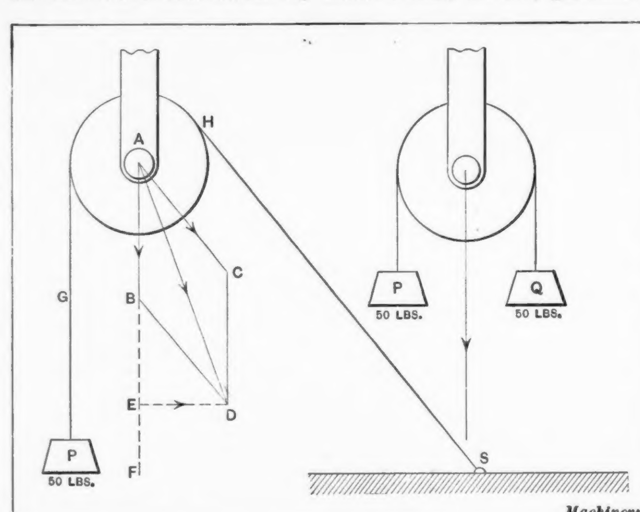
J. J.

STRESS ON PULLEY AXLE

S. J. C.—In the accompanying diagram a pulley is shown rigidly fastened to a support at a height AF = 9 feet from the floor. A rope passing over the pulley has one end attached to a staple S at a distance of 8 feet from F, and to the other end is attached a weight P of 50 pounds. What is the total force acting on the pulley axle? I claim that it is 50 pounds, the same as the weight, but a friend says that it is more than that; which of us is right?

A.—Your friend is right, as a little consideration will show. Referring to the view at the right, one weight Q of 50 pounds exactly balances the other weight P of 50 pounds; and since the pulley supports both weights, the total force (or stress) on the axle is $50 + 50 = 100$ pounds. Suppose, now, that one of the weights were removed and that the free end of the rope were fastened; then, in so far as the stress on the axle is concerned, the conditions would be exactly the same as before, provided the two parts of the rope were parallel. Thus, suppose the weight Q were removed; the weight P tends to fall and pull the rope along with it. But this is resisted by fastening the free end of the rope. As a result, P acts downward and the reaction acts upward; on the other side, P acts upward and the reaction acts downward. The reaction in the second case corresponds in every respect to the force Q; hence, the total stress on the axle is 100 pounds, as before.

Under the conditions shown in the left-hand view, a part of the reaction of the staple tends to pull the pulley away from the perpendicular, and the stress on the axle is less than the sum of the stresses in the two parts of the rope. To find what this stress is, draw a line, as AB, parallel to



Stress on Pulley Axle

the part G of the rope, and make it of a length that will represent 50 pounds; draw AC parallel to HS, the other part of the rope, and make it of the same length, also representing 50 pounds; complete parallelogram $ACDB$, and draw diagonal AD; this measured to the same scale as AB gives the stress on the axle and shows the direction in which it acts. By producing AB and drawing DE perpendicular to it, ED represents the force tending to pull the pulley from the perpendicular, and AE represents the downward force on the axle. Assuming the pulley to be 1 foot in diameter, the writer obtained in this manner the following values: AD = 94.25 pounds; AE = 88.75 pounds; and ED = 31.75 pounds. By calculation, AD = 94.19, AE = 88.72, and ED = 31.64.

J. J.

MESTA HERRINGBONE GEAR PLANER

MACHINE DEVELOPED FOR CUTTING HEAVY GEARS AND PINIONS

THE well-known advantages possessed by properly cut herringbone gears as compared with the standard type of cut spur gears or cut spur gears with staggered teeth, have led to an increasing demand for herringbone gears. In order to secure the full benefit resulting from the use of this type of gear, however, it is absolutely necessary for the cutting to be done on a machine capable of producing accurate work. For rolling mill equipment it is often desirable to use herringbone gears of very coarse pitch because slight inaccuracies in alignment, which are unavoidable in mill practice, do not exert such a detrimental effect upon their operation and life. In cutting coarse pitch gears of this kind excellent results are obtained by planing the teeth, and there is no limit to the pitch of gear that can be cut in this way. To meet the requirements of this work the Mesta Machine Co., Pittsburg, Pa., has developed a planer type of herringbone gear cutter which it is the purpose of the following article to describe.

In comparing the design of this machine with that of other herringbone gear planers, the most noticeable features are: (1) That the position of the gear blank remains fixed while the tools are made to follow helical paths required to finish elements of the tooth faces. (2) That the carriages which support the cutting tools occupy a fixed transverse position on the machine, while the headstock and tailstock that support the work are moved transversely to obtain the required setting for planing teeth in gears of various sizes. It is claimed that greater accuracy can be obtained by holding the work stationary and having the tools follow helical paths determined by the angles of the teeth, because the gears cut on this machine are large and heavy, and would gather considerable momentum if it were attempted to rotate them for cutting herringbone teeth while the cutters were following paths parallel to the axis of the gear.

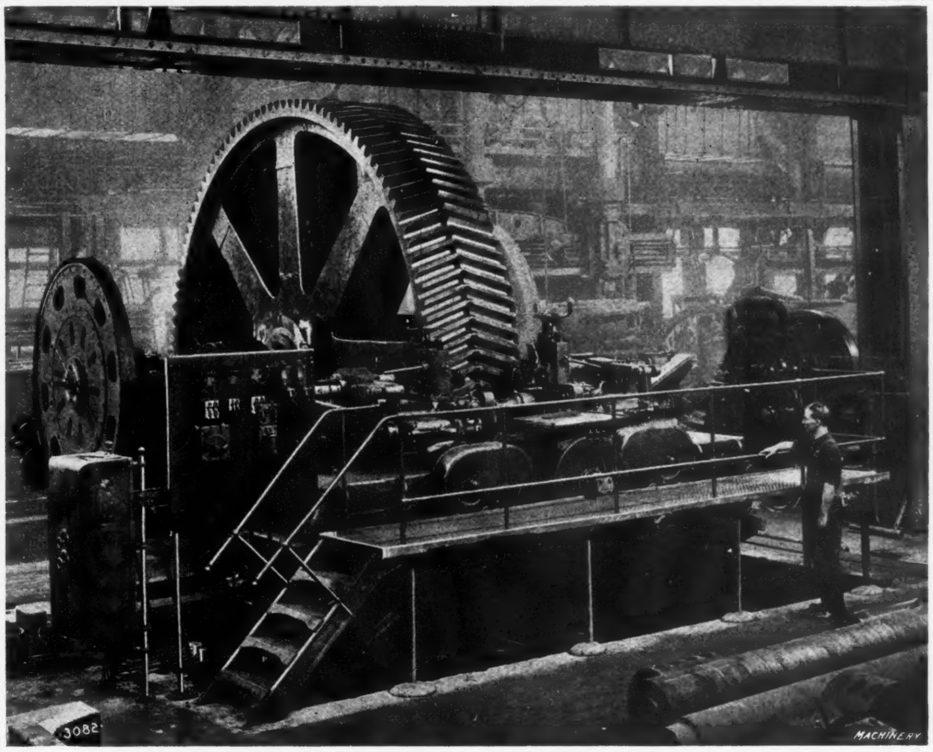


Fig. 1. Herringbone Gear Tooth Planer developed by Mesta Machine Co. for Heavy Work

In the operation of this machine one side of a tooth is planed, after which the machine is stopped and the tools are backed out to the starting position by hand; the work is next indexed so as to bring the corresponding side of the next tooth into proper relation with the tools, after which the work is locked in place and the tools started cutting. This procedure is continued until all of the teeth have been cut on one side, and in this connection it may be mentioned that either the upper or lower sides of the teeth may be cut first. After the work has been indexed through one complete revolution, *i. e.*, after all the teeth have been cut on one side, it is necessary to adjust the setting to bring the opposite side of the first tooth into proper relation with the cutting tools. In securing this result, the work is brought into approximately the desired position, after which a very light cut is taken and the tooth tested with a gage to ascertain the amount of metal which must still be removed in order to reduce it to the desired thickness. Several trial settings will be made in this way and light cuts will be taken, gaging the tooth after each cut, until the desired setting of the work has been obtained; then cutting and indexing operations will take place alternately—as in the case already explained for cutting the first side of the teeth—until the gear has been indexed through another complete revolution, which finishes the cutting of the teeth.

In order to describe just how the machine operates, it will probably be best to explain the conditions which must be fulfilled in cutting the side of one tooth and the mechanical means provided for this purpose. The conditions imposed in planing herringbone gear teeth on the Mesta machine are as follows: (1) The tools must follow paths which conform to the helix angles of corresponding teeth at each side of the gear. (2) The position of the tools must be kept in constant relation to the faces of the teeth, *i. e.*, the tools must be held normal to the tooth profiles at all times. (3) Compensation must be provided for curvature of the teeth due to their angularity. (4) After completing each stroke the tools must be fed in toward the axis of the gear. (5) The position of the tools must be constantly adjusted so that the desired involute profile is obtained for the teeth.

The way that a reciprocating motion is imparted to the tool carriages, and the manner in which the tools are made to follow paths corresponding with the helix angles of the teeth are clearly shown in Fig. 2. Referring to this illustration, a thirty-five horsepower Westinghouse electric motor which drives the machine is shown at *A*. This motor is of the reversing type and transmits power through bevel pinions *B* to lead-screw *C*, reversal of the drive taking place at such intervals that the desired length of stroke is imparted to the cutting tools. It will be seen that the tool carriages run on inclined ways *D* which are set at angles to correspond with the required helix angles for the gear teeth. In making this setting the stand which supports the driving motor is raised by elevating screws, which results in raising the inner ends of the inclined ways *D* on which the tool carriages reciprocate. When this setting has been obtained, screws *E* are manipulated in order that supports *F* under the outer ends of the tool carriage ways may be moved sufficiently to obtain

the required angular setting, which is ascertained through the use of a bevel protractor and spirit level. Teeth with helix angles ranging from 12 to 23 degrees can be cut.

In referring to conditions that must be fulfilled in planing herringbone gear teeth, mention was made of the necessity of maintaining a constant relation between the position of the cutters and the tooth profiles, *i. e.*, the tools must be kept normal to the tooth faces. Provision is made for securing this result by rocking the tool-holders on shafts *G* so that a constant relation is maintained as each tool passes over the gear tooth that it is cutting. Fastened to each of the inclined ways over which the tool carriages run there is a rack; and secured to each of the carriages there is a cross shaft with a pinion at its outer end that meshes with one of these racks. At the opposite end of the shaft there is a worm which meshes with a worm-wheel segment on the tool-holder, as shown in Fig. 3; and it will be evident that as the carriage moves back and forth, engagement of the pinion *H* with the rack results in rotating the cross shaft, worm and worm-wheel segment, and thus rocking the tool-holder about shaft *G*. In this way compensation is provided for the "wind" of the gear teeth due to their angularity, and a constant relation is maintained between the planing tools and tooth profiles. The tool-holders are rocked through an angle shown at *DEF* in Fig. 4.

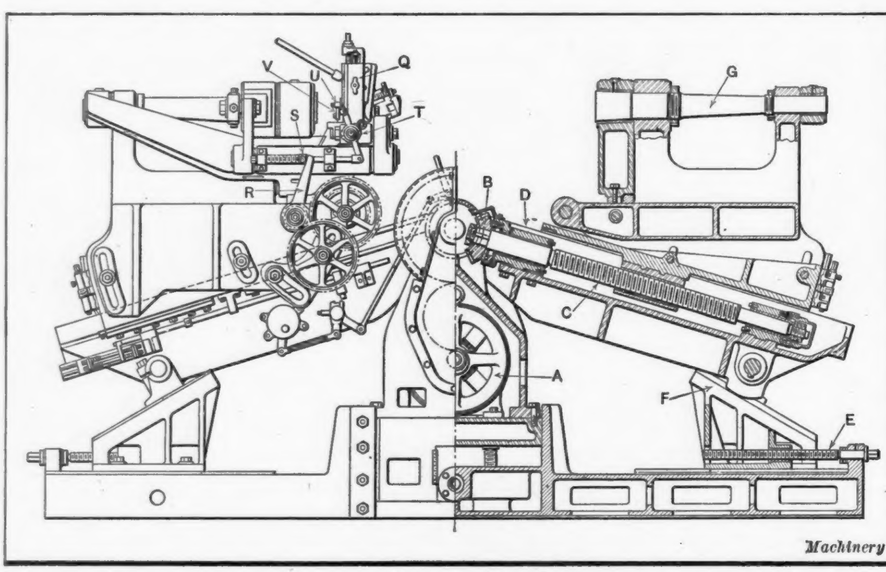


Fig. 2. Mechanism for securing Reciprocating Movement of Carriages on Paths corresponding to Helix Angle of Teeth; also Means of obtaining Cross-feed and Involute Tooth Profile

In planing herringbone gear teeth it is also necessary to make compensation for curvature due to angularity of the gear teeth, *i. e.*, in passing across the gear face, center *A* of each tooth, Fig. 4, is higher than either end by an amount *BC*. In setting up the machine each tool is located at a central point *A* and it will be evident that means must be provided to make the tool follow the curved path of the teeth, the amount of adjustment necessary varying according to the diameter, helix angle and face width of the gear which is being planed. The method by which this compensation is secured is illustrated in Fig. 3. Referring to this illustration it will be seen that arm *I* carries link *J*, and as arm *K* rocks up and down, link *L*, which connects arm *K* and shaft *M* with link *J*, swings in and out relative to arm *K* due to the comparatively short

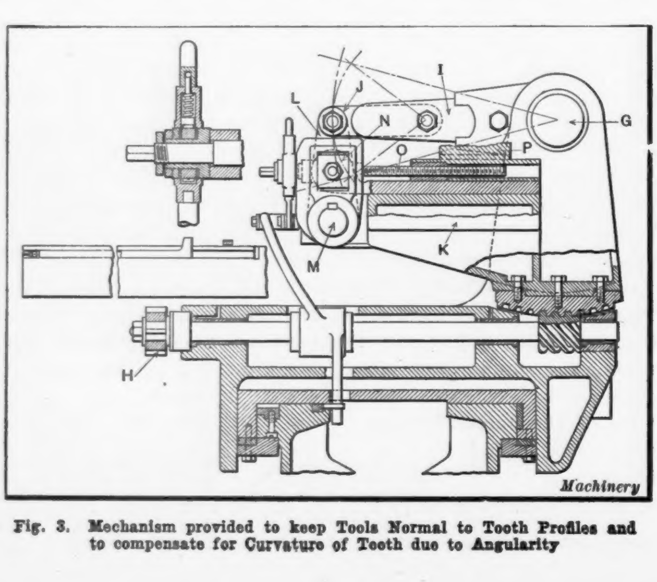


Fig. 3. Mechanism provided to keep Tools Normal to Tooth Profiles and to compensate for Curvature of Teeth due to Angularity

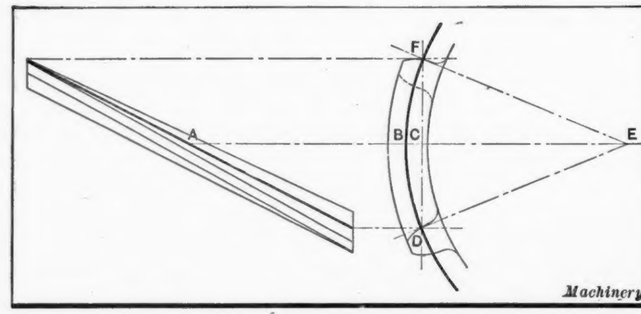


Fig. 4. Diagram showing Conditions that must be fulfilled in planing Herringbone Gear Teeth

length of link *J*. This relative motion is transmitted by means of block *N* and screw *O* to tool-holder *P*. The tool is at the center of shaft *G* when in the central position so that the working of arm *K* does not affect the position of the tool.

On each of the tool carriages there is a compound tool-block *Q* fitted with horizontal and vertical slides. The horizontal slides are used for feeding the tools in toward the axis of the gear, this feed motion being actuated at the end of each return stroke of the tool carriages. The manner in which this result is obtained is shown in Fig. 2; lever *R* is of bell-crank form, the lower portion not being shown. When the carriage approaches the limit of its return motion, this lever comes into contact with block *S*, which is secured to the feed-rod. Further movement of the carriage results in lever *R* pushing block *S* and the feed-rod over, thus turning a feed-screw that operates the horizontal slide of tool-block *Q* by means of a ratchet and pawl mechanism shown at *T*. Adjustment is provided to vary the amount of feed according to the requirements of the work. In addition to the horizontal slide, each tool-block *Q* is furnished with a vertical slide to which is secured roller *U* which runs in contact with templet *V*. As ratchet mechanism *T* feeds the tool in toward the axis of the gear, roller *U* rides over templet *V* and causes the tool to be raised by movement of the vertical slide; and as templet *V* corresponds to an involute tooth curve of the required pitch, it will be evident that this results in securing the desired contour for the gear teeth.

Indexing of the work is done by means of the large worm-wheel shown at the left-hand end of the machine, this wheel being driven by a worm that receives power from an independent five-horsepower motor. The design of the index mechanism is essentially the same as that used on other forms of gear tooth planers, so that a detailed description is not called for; but in this connection it may be mentioned that indexing is effected through the familiar arrangement of differential gears and a locking bolt which drops into place to secure the work against further movement when it has been brought into the desired position ready for cutting a tooth. After indexing has been completed the operator starts main driving motor *A*, Fig. 2, to set the machine in operation, and when the cutting of the tooth has been completed and the tool-heads have been backed out to the starting point, the first step is to release the lock bolt on the index mechanism, which is done by pulling a pendant cord which hangs down at the front of the switchboard at the left-hand end of the machine.

Then the switch governing the indexing motor is closed in order to start this motor running to index the work.

The gear blanks in which teeth are cut on this machine are steel castings in which the teeth are cast to approximately the desired form so that it is merely necessary to finish them on the machine. Those experienced in the production of steel castings know that particular attention must be paid to provision of means to take up shrinkage. Gear blanks are usually cast in halves and unusually large shrink heads are provided so that there will be ample metal to drop down into the mold as the metal shrinks in cooling. These castings are planed on the joint between the two halves, and the halves are then secured together with bolts and shrink keys, after which the work is ready to be set up on the machine. The first operation consists of taking a roughing cut with a square nose tool, which removes excess metal from the tooth spaces. After this has been done a finishing cut is taken according to the method already described, and in taking this cut a pointed tool is employed, guided in the same manner.

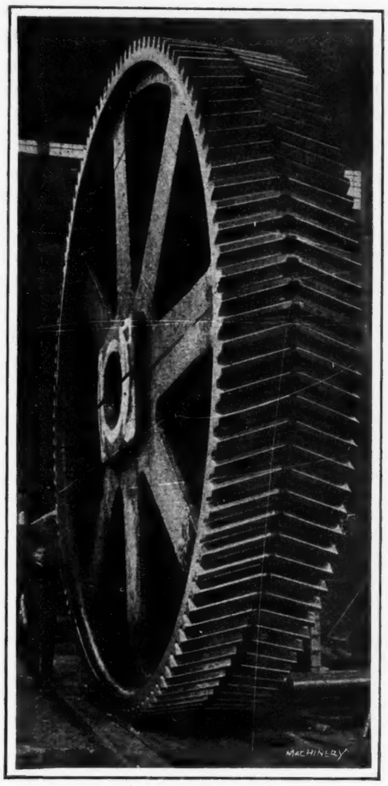


Fig. 5. Large Herringbone Gear which had Teeth planed on Machine

The diameter of gears which can be cut is limited only by the pit capacity; and at present the machine is so arranged that gears up to 22 feet in diameter can be accommodated, but this could easily be increased should the necessity arise. The maximum face width of gears which can be cut is 5 feet, 6 inches. An idea of the accuracy obtained may be gathered from the fact that during each cutting stroke the tool follows a true helix within limits of 0.0005 and 0.001 inch. Errors due to deformation of the tool and support, and to wear of working surfaces are exceedingly small because all parts of the machine were so designed that they are of ample size. The machine occupies a floor space of 26 feet by 26 feet, and weighs approximately 150,000 pounds. E. K. H.

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The Ford Motor Co. of Detroit made $59,994,118 profit for the year ending July 31; it built upwards of 500,000 cars, the selling price of which was $206,867,347. The company employs 49,870 men in all its plants, and of these, 36,626 receive $5 or more a day. More than 27,000 are employed in Detroit.

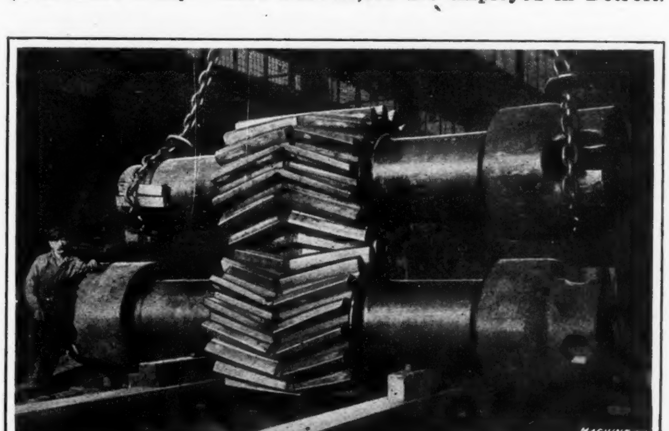

Fig. 6. Herringbone Pinions for Rolling Mill Service

MODERN POWER DEVELOPMENTS

In an interesting address delivered before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, on "Power and Its Application in Modern Industries," Dr. C. P. Steinmetz, chief consulting engineer of the General Electric Co., Schenectady, N. Y., pointed out that the main difference between our present civilization and that of a hundred or a thousand years ago is that in those days man depended entirely upon his immediate surroundings, whereas today, through the facilities of transportation, he can command the energy and the materials of the whole world at any point within the reach of the systems of transportation. Apart from passenger traffic, the speaker pointed out that the means of transportation served two purposes: (1) that of transporting materials—that is, the things actually used by mankind for comfort and pleasure; and (2) the transportation of potential energy. Coal, peat, etc., is not transported as a material, but simply because of its potential energy. Coal is transported not because it is wanted in itself, but simply that it may be burned as soon as possible upon its arrival, thereby liberating the potential energy tied up in it and producing power. With the progress of engineering, still simpler means of transporting energy than carrying coal have been invented, the electric current making it possible to cheaply transmit energy.

Not only is electrical energy more easily transported than any other known form of energy, but one of the greatest advantages of electricity is that it can be used in small quantities with almost the same efficiency as when used in large quantities. A motor of one-eighth horsepower is, practically speaking, as efficient as one of 10,000 horsepower. It is true that, expressed as a percentage, the larger motor is more efficient; but comparatively speaking, the difference is slight. With steam, gas or oil engines there is no such comparison. The large steam or gas engine is highly efficient, but an engine of one-eighth horsepower would be exceedingly inefficient. Imagine, if you can, a little boiler with its furnace placed on the office desk, and pipes leading to a small engine with a flywheel belted to a pulley mounted on the shaft of an ordinary desk fan. The arrangement would, of course, be impossible, but with the electric motor it is a simple matter to transmit power efficiently to drive a desk fan.

It was also pointed out that in the modern development of electric power the country is covered with a power-distributing network, which, on a map, might be likened to the network of railroads some fifty years ago—isolated systems that were only here and there connected to complete trunk lines; so, today, the electric systems are not yet connected into one complete network, and just as the railroads in the early days had different gages, so these systems are now of different cycles and the power from one is not directly interchangeable with the power from another. In the near future, however, sixty cycles will predominate for electric power transmission systems. The systems can then be linked up, and, in the case of the temporary failure of one system, power from other systems can be turned into it and the industries dependent upon the electric power will not be inconvenienced. There are hydro-electric power stations today that are able to produce electric power at the source as cheaply as 0.15 cent per kilowatt-hour, and power is being sold to consumers as cheaply as 0.62 cent per kilowatt-hour. The reason why power in cities is so much more expensive than power near hydro-electric plants in the country is that the distributing systems in the cities require an outlay of capital so much greater in proportion to the power actually consumed that the charges for interest and depreciation are much higher than the cost of the power itself. Hence, it is difficult to compare kilowatt rates in cities with those in the country near power plants.

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An indication of the widespread interest in engineering circles as to our future commercial and engineering relations with South American countries is given by the fact that 180 out of 231 students entering Stevens Institute of Technology this fall have elected to study Spanish instead of French or German. This is a most remarkable increase in proportion over other years at Stevens in favor of Spanish.

SEMI-AUTOMATIC SHELL MAKING MACHINES

EQUIPMENT FOR MACHINING BRITISH 18-POUNDER HIGH-EXPLOSIVE SHELLS

A SHELL making equipment, consisting of two semi-automatic machines capable of turning out a completed 18-pounder British high-explosive shell in six minutes, has been built by the Manitoba Shell Co., St. Boniface, Manitoba. One of the machines performs the operations on the interior of the shell, and the other, the operations on the exterior. In other words, when the shell leaves these two machines it is completed and ready to have the band pressed on. It requires only two operators to attend to the two machines, and their production is equal to that of eleven ordinary machines equipped with special attachments for handling the various operations. All lubricating pipes and stop-cocks are opened and closed automatically as required. Every tool-holder has an adjusting mechanism graduated to 0.001 inch for adjusting the tools to depth. The "internal" machine is provided with eight work-holding spindles and the required number of opposed tool spindles for boring, reaming, facing, threading, etc., whereas the "external" machine is provided with six spindles for performing all the operations on the exterior of the shell.

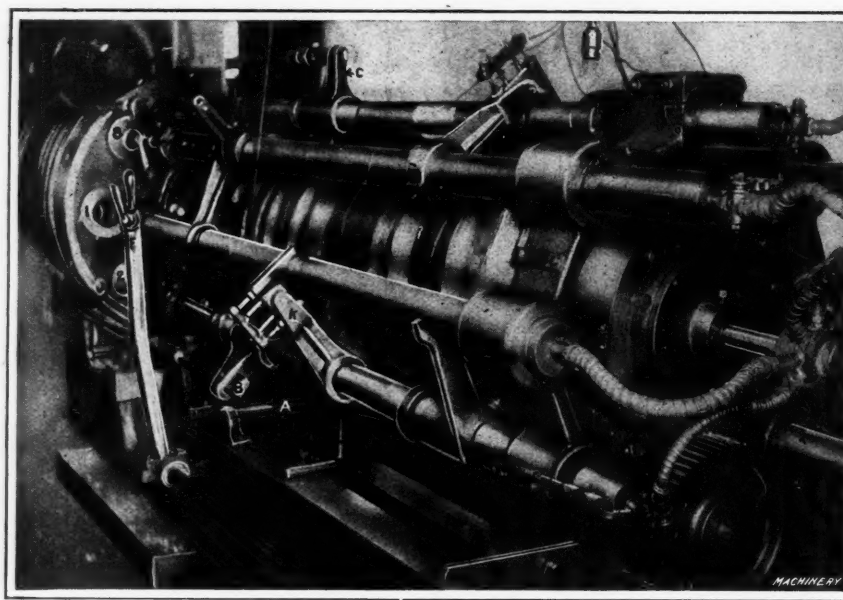

Fig. 1. Semi-automatic Shell Making Machine for performing Operations on Interior of British 18-pounder High-explosive Shells

Construction and Operation of Semi-automatic Machine for Performing Interior Operations

A front view of the machine for performing the operations on the interior of the shell is shown in Fig. 1, and a longitudinal section of the machine is shown in Fig. 2. All the movements of this machine receive power from a twenty-seven-horsepower motor located at the left-hand end on a bracket. This motor, through suitable gearing, rotates and indexes the head carrying the eight work-holding chucks for the shell, and at the same time operates a cam drum for controlling the longitudinal movement of the various boring, reaming, facing, tapping and recessing bars or spindles. The chucks, of course, are independently rotated by gearing in a somewhat similar manner to the spindles of a multiple-spindle automatic screw machine and are provided with two speed changes, for drilling and tapping, respectively, which are effected by means of a pin clutch. The speed of the work can be varied, depending on the hardness of the material, three changes in the driving motor being available, and is controlled electrically, as will be subsequently explained. The rotating head has one idle position, which is indicated in Fig. 1 as No. 1, for loading the work. When in this position, the chuck, of course, does not rotate.

Referring to the diagram Fig. 3, the sequence of operations accomplished on this machine is clearly outlined. After the shell has been located in the chuck, the set-screws shown in Figs. 1 and 2 are tightened, centering the shell and at the same time holding it rigidly in position. A stop (not shown in the illustrations) is used to push the shell up against and locate it so as to distribute the amount of material to be removed from each end. The machine is started and stopped by operating handle *F*, Fig. 1. The first position, as indicated, is the loading and unloading position, the work-holding chuck remaining idle so that the operator can insert and remove the work without stopping the other movements of the machine. In the second position, the blank is operated on from both ends, the work rotating at 139 R. P. M. The first opera-

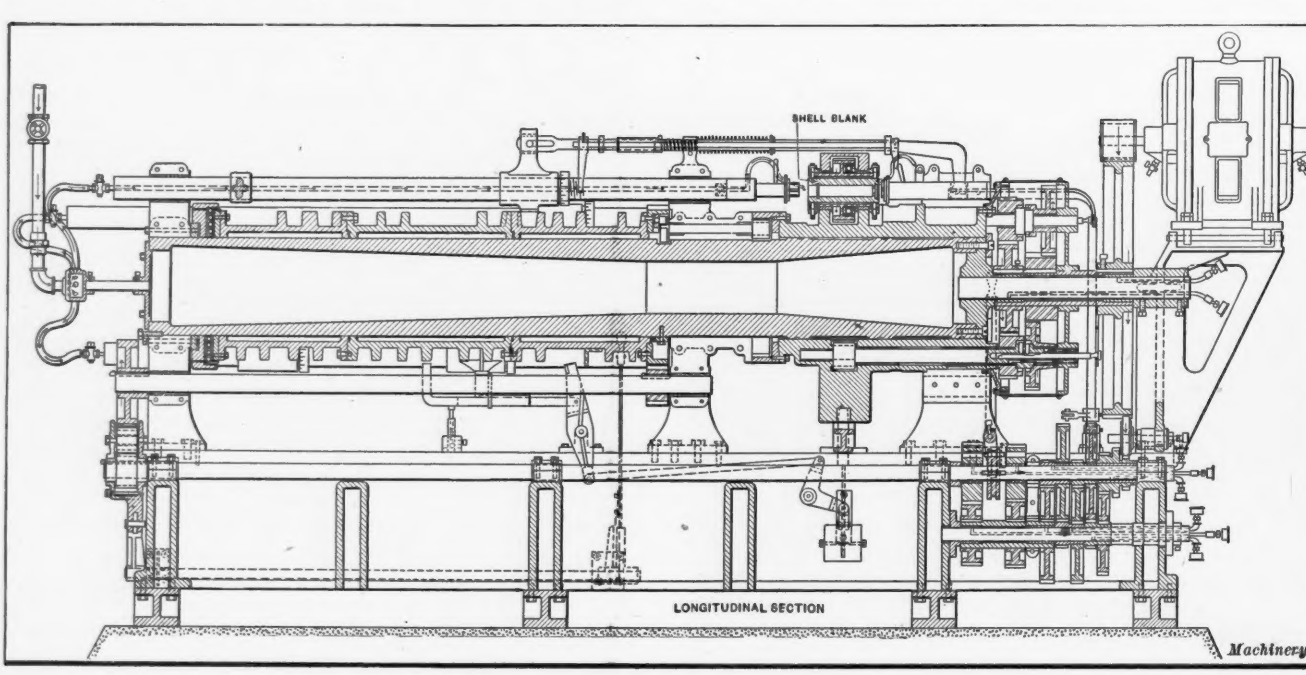

Fig. 2. Longitudinal Section of Machine shown in Fig. 1, illustrating Method of driving, etc.

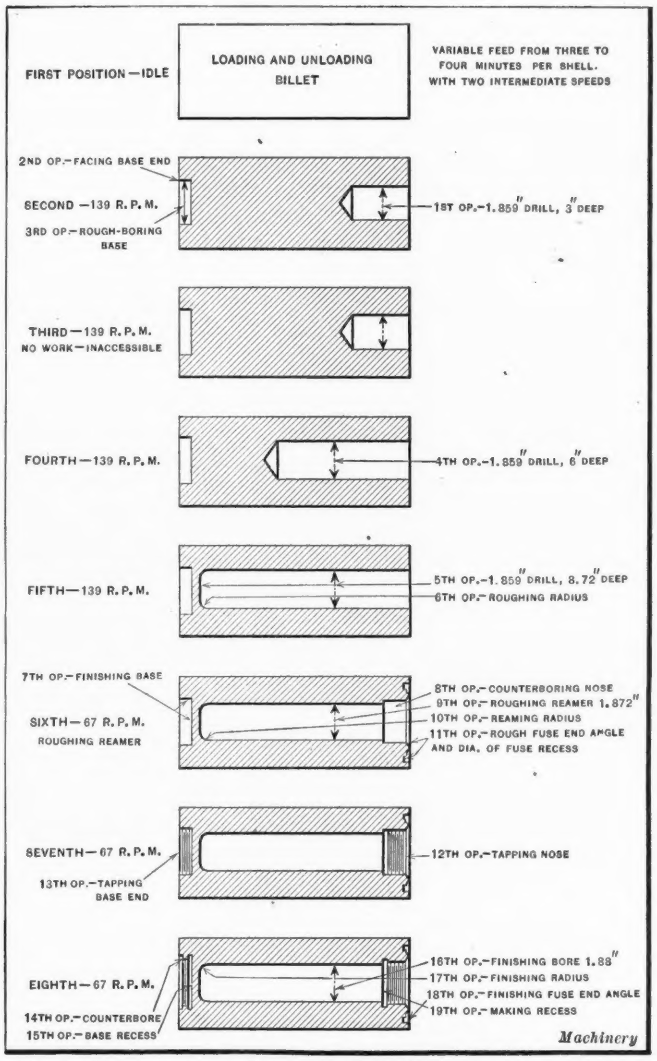

Fig. 3. Diagram showing Sequence of Operations performed on Machine shown in Fig. 1

tion consists in drilling a hole 1.895 inch diameter, 3 inches deep in the nose end; and the second and third operations consist in facing off the base end and rough-boring the pocket for the base plug. In the third position, no operations are accomplished for the reason that this position is inaccessible. Hence the third position is not used for any of the machining operations.

In the fourth position, the work is still rotating at 139 R. P. M., and it is operated upon at one end only by a drill 1.859 inch diameter, which advances 3 inches farther than the first drill, thus extending the hole in the nose end of the shell to 6 inches. In the fifth position, the work is still rotating at the same speed, and all the operations are performed from

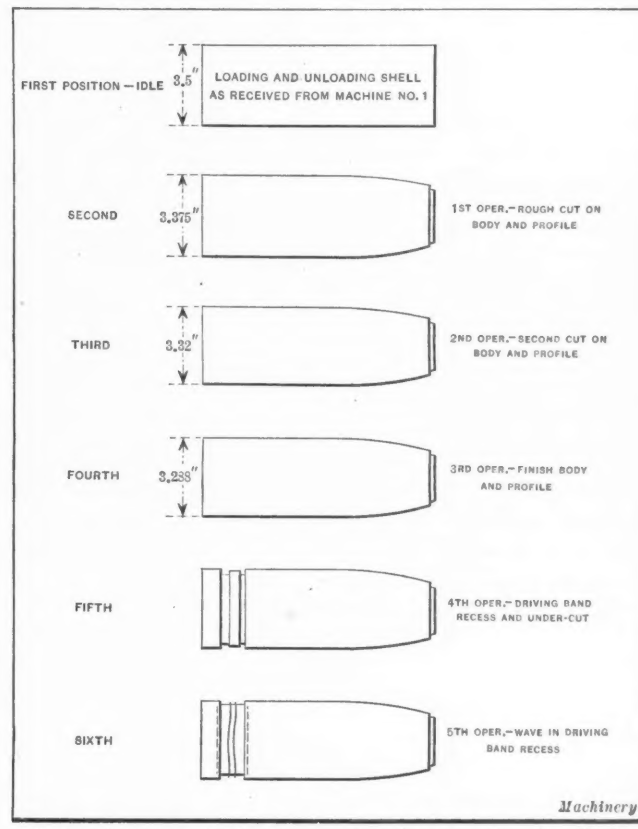

Fig. 4. Diagram illustrating Sequence of Operations performed on Machine shown in Fig. 7

the open end. The fifth operation consists in finishing the 1.859-inch hole, which is now extended to a depth of 8.72 inches; and the sixth operation consists in roughing the radius at the bottom of the pocket. In the sixth position, the seventh operation consists in finishing the base end with a roughing

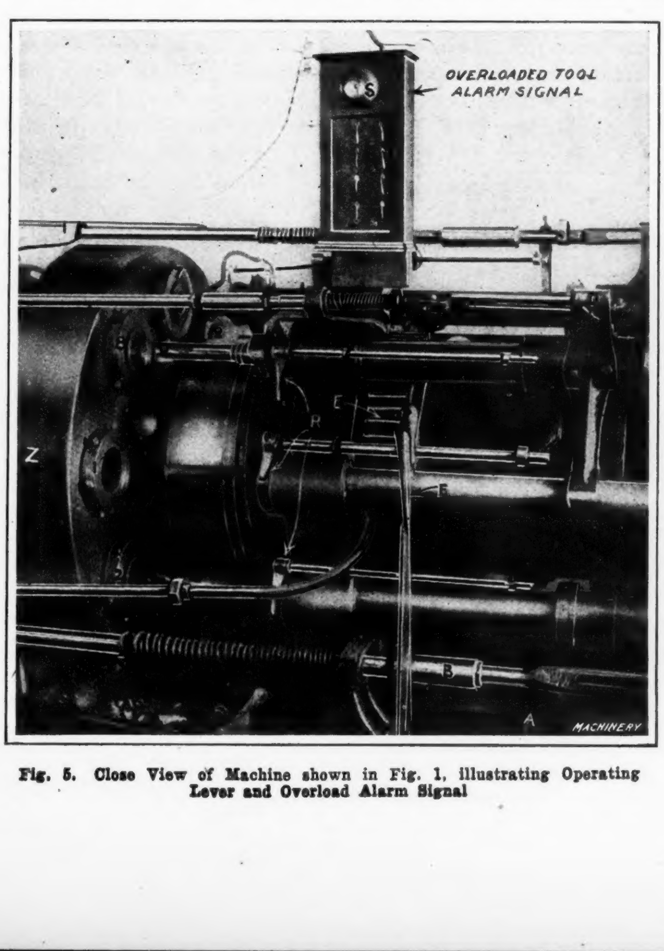

Fig. 5. Close View of Machine shown in Fig. 1, illustrating Operating Lever and Overload Alarm Signal

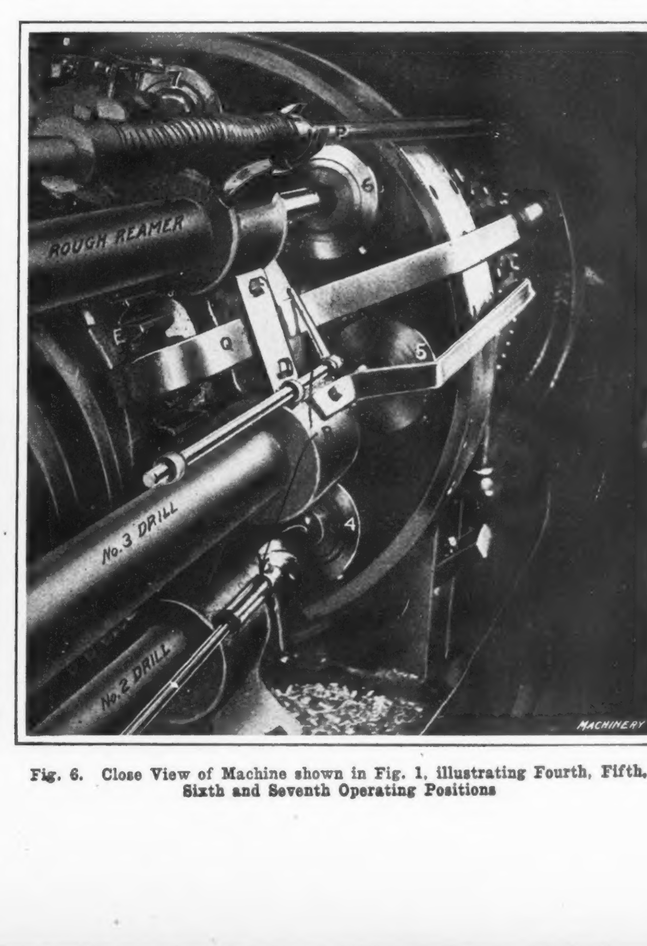

Fig. 6. Close View of Machine shown in Fig. 1, illustrating Fourth, Fifth, Sixth and Seventh Operating Positions

reamer, the work being rotated at 67 R. P. M. On the opposite end of the shell, the eighth operation consists in counterboring the nose; the ninth in rough-reaming to 1.872 inch diameter; the tenth, in finishing the radius on the nose; and the eleventh in roughing the fuse end angle and diameter of the fuse recess. In the seventh position, the work is still rotating at 67 R. P. M. and the thread is cut in both ends. Reference to Fig. 2 will show that the two collapsible taps are operated by opposed spindles, which are in line with each other. The twelfth operation, therefore, consists in tapping the nose, and the thirteenth, in tapping the hole in the base end for the base plug. In the eighth position, the work is still rotating at 67 R. P. M., and the fourteenth operation consists in counterboring the seat for the base plug; while the fifteenth operation is recessing the base seat. The sixteenth operation consists in finishing the bore with a reamer 1.885 inch diameter; the seventeenth in finishing the radius at the bottom of the pocket; the eighteenth in finishing the fuse end angle; and the nineteenth in making the recess in the open end. This finishes the operations on the shell and brings it to the unloading position. It should be understood, of course, that it requires one complete revolution of the work-spindle head to finish all the operations on the ends and interior of one shell, and during this time nineteen drilling, facing, chamfering, reaming and threading operations are performed upon it.

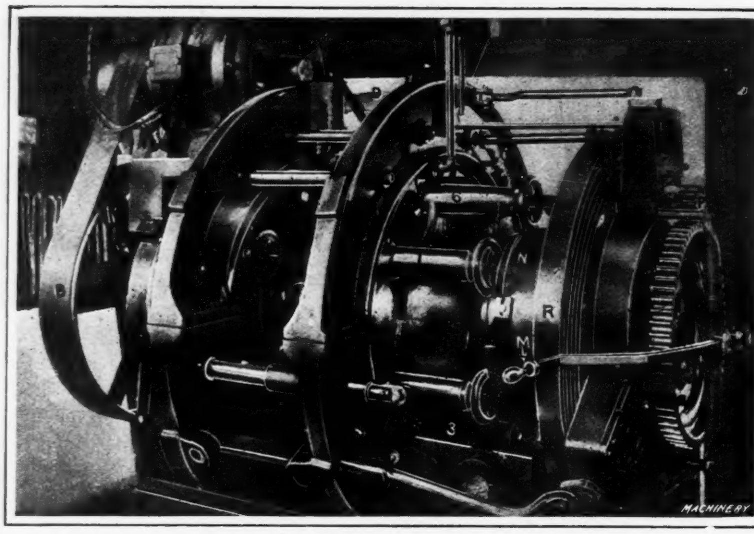

Fig. 7. Front View of Semi-automatic Machine for machining Exterior of British 18-pounder High-explosive Shell

Owing to the impracticability of using the third position, it is necessary in several positions to use two tools working from the same end. In the second position the hole for the base plug is both drilled and counterbored. In order to accomplish this, adjustable arm *B* is provided, as shown in Fig. 5, which brings the boring tool into position after the drill has cleared. Reference to Fig. 3, of course, will show that the hole in the nose of the shell is over four times as deep as the one in the base, so that sufficient time is allowed both to drill and counterbore the hole in the base. It should also be noted that in the sixth position it is necessary to use two tools, which cannot be operated at the same time. Therefore, an adjustable feed-rod *P* is provided for bringing the base facing tool into operation whenever the roughing reamer is clear of the hole. It is also necessary to use two tools in both the seventh and eighth positions. As shown in Fig. 6, an adjustable arm is provided in the seventh position for bringing the base tap into operation whenever the nose tap is clear. It is evident, of course, that both taps cannot work at the same time, because both are right-handed. The adjustable arm *D* is used to bring the base recessing tool into operation in the eighth position when the base reamer is clear of the hole.

As shown in Fig. 5, the lever *A* is the locking and unlocking device for the spindle carrier drum, the latter being rotated by the gear *E*, which indexes the head *Z* one-eighth revolution upon the completion of each operation. Fig. 5 also shows the devices used at *R* for setting the various tools to depth. The rod carrying these levers is provided with an adjustable collar so that the different tools can be set by these stops in the desired position. Another point that has not been mentioned is the automatic electric alarm *S*. Should the cutting tools strike a hard shell so that the power necessary to force the tools into the work is greater than that required under ordinary conditions, this alarm electrically operates the rheostat on the motor and reduces its speed. The machine can also be so set that it automatically reverts to the previous speed when softer material is encountered. The construction of the electric alarm device for controlling the machine when hard spots are encountered is shown at *K* in Fig. 1. This device, as will be noticed, is connected with the various spindles, the successful operation of which would be affected by the tools striking hard spots in the material. The application of electrical means for controlling the movements and working capacities of machines is being more generally adopted as the advantages to be derived from this method of control are becoming recognized. In this case the machine automatically accommodates itself to the hardness of the stock. Lubrication is pumped into all the tools, as illustrated in Fig. 2, so that they are kept cool.

Semi-automatic Machine for Performing Operations on Exterior of Shell

The machine for performing the operations on the exterior of the British 18-pounder high-explosive shell is shown in Figs. 7 and 8. This machine differs in principle from that illustrated in Fig. 1 in that it is not of the double-end type, as all the work is done on the exterior and not on the ends and interior of the shell. Also, it is only provided with six spindles or "lathes" instead of eight work-holding positions.

In principle, the machine consists of a large central drum carrying six tailstocks and six headstocks. The work to be finished is held on special arbors located by the headstock and tailstock. The cutting tools are carried by operating slides that receive motion from a drum cam which brings the various cutting tools into action on the work. These tool-holders are also moved longitudinally, the work remaining stationary, except for rotating and being indexed around to the various tool positions. The machine is driven by a fifteen-horsepower motor by a single belt. Gears were at first used for driving the machine from the motor, but it was found that the belt worked much better. All the mechanism of the machine is uncovered and is operated from cams and rockers as described in a preceding part of the article.

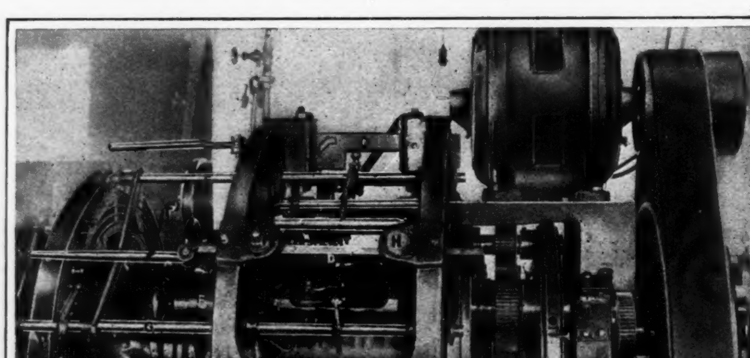

Fig. 8. Rear View of Machine shown in Fig. 7, illustrating Operating Cams, Tool-holders, etc.

The first two cuts, as outlined in the diagram Fig. 4, are made with four cutters on each "lathe"; the third has one tool and finishes the entire length. Reference to Figs. 7 and 8, which show front and rear views of the machine, will give an idea of its construction. The machine is driven from the main driving pulley *B* through a friction gear (not shown), which stops the rotation of the "lathe" at the loading point. *C* is a counterweight for the locking device which is used when the head is indexed into the various positions; the indexing is accomplished by the pinion *P*, which transmits motion to the large gear just beneath it and is operated by a cam sleeve to rotate the drum carrying the lathe heads one-sixth revolution at the completion of each cut. The machine is started and stopped by operating the lever *M* located directly in front of the machine. The various tools are brought into and out of contact with the work by means of sliding wedges *D*, as shown, which, in turn, receive power from the large drum *R* carrying cams for operating the various tools.

Rod *E* governs the depth of travel of the driving band recessing tool, and it will be noticed that it also receives motion from drum *R*. The shaft *F*, on the other hand, is a rocker for the under-cutting tool for the band groove, and as shown in Fig. 8, also receives power from cam *R*. *G* is a feed-rod for the wave cutting tool and is operated in the same way as the other tools. *H* is a raising rod for the wedge bar *D*, and *J* is a rocker acting on the final finish cutting tool, the result of which is shown diagrammatically in Fig. 4. Most of the other details of the machine do not differ materially from the standard type of automatic screw machine or chucking lathe. The principle, of course, as a whole is quite unique. The production on this machine is one shell every three minutes, so that with material of the correct physical properties it is possible to turn out a complete shell, finishing both the interior and exterior on the machines shown in Figs. 1 and 7, respectively, in six minutes, or at the rate of ten an hour. D. T. H.

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NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The fifteenth annual convention of the National Machine Tool Builders' Association was held in New York City, October 24 and 25, at the Hotel Astor. The meeting was called to order by J. B. Doan, president, following which was the usual routine business, including reports of committees. J. H. Drury, chairman of the Membership Committee, reported that the following concerns had applied for membership: Fitchburg Grinding Machine Co., Fitchburg, Mass.; Sipp Machine Co., Paterson, N. J.; W. W. & C. F. Tucker, Hartford, Conn.; Simplex Machine Tool Co., Hamilton, Ohio; Nutter & Barnes Co., Hinsdale, N. H.; Cincinnati Grinding Co., Cincinnati, Ohio. Mr. Doan, in his presidential address, discussed the machine tool trade and the probable condition of business following the European war as follows:

A special feature of this association is the good fellowship of its members. Good fellowship, in the deeper sense of binding men together by the powerful ties of mutual self-interest and profound friendship, is a most valuable element in the development of every industry. Men have learned that cooperation is one of the necessities of business success. By combining our wisdom we learn better methods of manufacture; we learn that there is some better system of business than merely trying to cut the throat of a competitor, and we find that the concentrated rays of business friendship, like concentrated sunbeams, will melt the coldest and hardest markets. In other words, cooperation and the exchange of business ideas teach us to manufacture more scientifically, to keep costs more accurately, and to market our product more successfully. So let this membership get together, abandon business suspicion, and build up business confidence.

There never was a time when these fundamental laws of success were so essential to business men. We are living in the most momentous days of history, and are witnesses of the results which follow when national suspicion becomes national fear, and national fear turns to national hatred, leading to international destruction. We in America, enjoying as we do the privilege of living as a people without internal hatreds, without internal suspicions, without deep internal antagonisms, do not yet realize the greatness of these privileges. Such associations as ours keep alive in our country the great spirit of national trust and national cooperation. We come from coast to coast, from North to South, and meet with a common language and a common purpose. Let this unity increase and grow, and in the midst of this unity, do not fail to observe the horror that overwhelms nations and peoples who do not enjoy it.

As far-seeing business men living in these historic days, there are three elements of profound influence on the future which I would suggest that we consider deeply. First, the effect of the international war in Europe on our future, both at home and abroad. Second, the effect of the enormous business expansion which has come about in this country as a result of the war, both in the enlargement of old machine tool factories and the addition of new ones; and third, the effect of whatever changes in national laws may be made after the forthcoming election.

None but those who are blind and deaf can fail to comprehend that there will be terrific effects following the ending of the European war. Those effects follow all wars, as they follow floods, hurricanes and earthquakes. Even small wars leave an aftermath of physical and financial upheaval and distress. There will be debts to stagger the imagination, and there will be an instantaneous disappearance of certain business demands created by war. Peace will return to the industries of Europe approximately 20,000,000 men, supplemented by many women workers. The man who does not realize these conditions is, in my opinion, due for a rude shock. It will be a time for wise heads to acquire and use greater wisdom than they ever before possessed. No one can accurately forecast that future. It is all in the second act of the great tragedy.

We do know that after the Civil War, much as the South had need of everything under heaven, the South staggered on in poverty, unable to buy freely for more than a quarter of a century. Europe will be in need of everything; but the wherewith to buy, what about that? For Europe is blowing up its capital at the rate of the cost of a Panama Canal every week.

In the United States there has been immense business development during the last two years. Old machinery has been put in shape for work and new machinery has been built with break-neck speed. New buildings have been erected and expansion has been the order of the day in the machine tool industry along with others. Our demand has been due to the enormous call for machinery and supplies of every kind from Europe. We might picture business in America as a great forge made white hot, as the demand from Europe has blown upon it like a mighty bellows. The anvils have rung, the workers have toiled, and still the cry has been for more, more. But this Hercules of war will grow weary. The giant bellows will lose their force. Will there then be a sufficient demand to keep all busy? America wants and needs all the prosperity it can get; so in the midst of unprecedented prosperity let us not forget to prepare for other days.

In the days that are to come we need to enlarge our vision and build up the friendliest possible relations with other nations. In building up that business, the fundamental principle still holds. Tell exactly what your machine is when you try to sell it, and make it exactly as you have agreed to make it before you ship it. We want no soft spots in machine tools, no matter where they go. We are going to meet these different nations in the future, not merely on foreign soil, but perhaps on ours. It may be surprising to those who have not followed the statistics to know that, notwithstanding that practically all Europe is at war, we imported from the world during the fiscal year ending in 1916 goods valued at the astounding total of $2,197,000,000. This would have had a tremendous effect upon American industries and workmen if it were not offset in a measure by war orders. It will tax the ingenuity of Americans to meet that competition of the future. America is in a condition of the fat and well favored today. The old adage was "a lean hound for a long race." We will have to race with a lean and hungry hound after this war, so let us prepare for it.

We represent an industry that is fundamental in the world, more fundamental today than ever before. The struggle of the world has become one of machinery against machinery. If we did not know it before, the European war has taught us this fact. The nation with the largest and most powerful machinery, and the most of it, wins. It is still true, as Napoleon said, that "God fights on the side of the heaviest artillery." Our lathes, our turret machines, our planers, our milling machines, our fine mechanical devices of every nature are the war weapons of civilization. We represent a great industry. We manufacture the mechanism which keeps men always at the topmost point of civilized development. It is an honor to be a machine tool builder. It is a great honor to be a builder of good machine tools. It is more than an honor; it is a national responsibility, as it never was before, that the machine tool builders of America should be the builders of the best machine tools. Let us be worthy of that responsibility.

Concluded on page 275.

RUSSIA, THE AWAKENED LAND

During the past two years Russia has attracted more attention commercially than any other nation, largely because of its immense purchases of all kinds. Suddenly cut off from its accustomed sources of supply, this nation, which owns one-seventh of the land surface of the earth, found itself confronted with the problem of finding new markets in which it could buy, and to avoid a recurrence of this condition Russia began preparations for the development of its natural resources.

While the empire has an area of 8,505,957 square miles, or two and a half times the area of the United States with all its possessions, it is sparsely inhabited; the people for the most part till the soil, raise live stock, or are nomads. Only 13 per cent of the population of Eastern Russia live in cities; 23 per cent of that of Russian Poland; 12.9 per cent of that of the Caucasus; 11 per cent of that of Siberia; 13.5 per cent of that of Central Asia; and 14.6 per cent of that of Finland. In natural resources Russia is perhaps one of the richest countries in the world. The Ural Mountains are said to contain about every known metal; while the Altai and Caucasian Mountains, as well as other parts of the empire, are veritable storehouses of minerals. Though the metallurgical industry has been carried on with such indifference that at the beginning of the present century many blast furnaces and factories were torn down to avoid payment of the zemstvo taxes, so great is the mineral wealth of the country that in 1911 Russia ranked first in the production of platinum; second in the production of petroleum, asbestos, and manganese ores; fifth in the production of gold; seventh in the production of copper and asphalt; and eighth in the production of iron. It produced nearly all of the world's supply of platinum and approximately one-fifth of the supply of petroleum. The iron ores from South Russia are said to be the finest in Europe, some of the ore analyzing 70 per cent iron. The gold ores found in the Urals also supply much of the wolfram, osmium, tantalum and iridium used in the manufacture of electric lamps.

Several reasons have been given for the poor development of the nation's resources. Among the first is the sparsely settled condition of the country and the poor transportation systems. Owing to the marshy character of a large part of Eastern Russia and the lack of road-building materials, good roads are almost unknown; in fact, much of the marketing is done when the ground is frozen and sleds can be used. Yet so extensive a waterways system was developed early in the last century that by means of canalized rivers and the 1225 miles of artificial canals, the Baltic and Black Seas, and the Caspian, Baltic and White Seas were connected. Concessions have been granted for the building of many other canal systems. The Ob-Yenisei waterway system, in Siberia, is nearly 3650 miles long. In proportion to its population and area the railway mileage of Russia is small. The first railroads were built very slowly and were located so as to augment the transportation systems in existence and not as competing lines, with the result that they were not placed in many cases where they aided in the development of the country. About two-thirds of the lines, and those most of the important ones, are owned by the government.

Because most of the people follow agricultural pursuits, and also because of the inadequate systems of transportation, the buying and selling has been done at long intervals. This has caused the holding of fairs at which the people gathered in immense numbers. It has been estimated that 16,000 of these fairs are held annually, and that their sales exceed $500,000,000. Of course many of these are small and only of local interest, but some are of national importance and are known throughout the world. From 30 to 50 per cent of the furs found in the London and Leipsic markets were formerly bought at the Irbit fair.

The greatest factor in this tardy growth of the nation is now said to be the Germanic influence, which has dominated the Russian government since the days of Peter the Great. The Germans have secured the greater part of Russian trade through this influence and through their willingness to adapt their methods to Russian conditions. In a recent issue, *Engineering* of London told of two brothers who bought and quietly worked a small farm in Siberia until they had gained the confidence of those living in the surrounding region. Then they offered to teach better farming methods to all who would pay them a certain percentage of the increase in the crops, and the machinery necessary for the success of their methods they sold on three yearly installments. With the extra depth of soil turned over by the machine plow, the risk incurred by the brothers was small and the profits were so large that they were able to retire to Germany at the end of a few years.

Germany's dominance in the year 1913 is shown by the fact that of the $18,747,730 worth of machinery bought by Russia, Germany sold $14,626,050, while the United States sold only $211,342; of cast-iron products Germany sold $1,366,837, and the United States $20,553; of manufactures of copper alloys Germany sold $4,708,065, the United States $15,136; of tin-plate manufactures, Germany sold $2,653,491, the United States $15,631; of metal-working machinery, Germany sold $5,488,934, the United States $244,405; of dynamos and electrical motors, Germany sold $4,431,762, the United States $14,180; of parts of machinery and apparatus, Germany sold $6,966,330, the United States $601,254; of electrical appliances, Germany sold $3,196,215, the United States $51,576; of motor cars and trucks, Germany sold $7,102,264, the United States $300,760.

It has been estimated that German firms sold to Russia about two and one-half times as much American machinery and machine tools as was imported direct from the United States. A good part of this was sold at the Nizhni Novgorod fair and paid for at the fair the following year; the American firms, however, were paid cash in New York. So well developed was the German credit information service that the losses of one firm in the last twenty years are said to have been less than two per cent. English firms usually require a one-third payment with the order, one-third when the goods are shipped, and one-third when the goods are received.

The true reason for the slow growth of Russia seems to have been a lack of fuel and of capital. While the country has many large coal deposits, some of it is of an inferior quality and much that is of good quality has been inaccessible. Railroads are being built to these deposits, so that it is thought the fuel supply will be sufficient for a long time to come. Plans are being made for the conservation of this supply by making as wide a use as possible of the water power, of which there is an abundant supply.

The Russian markets are increasing in size and importance and are demanding better articles than two years ago. During the war several ports have been developed and new ones have been built, necessitating the construction of new railroads, some through territory that heretofore has been inaccessible. Existing roads have also been extended and in some cases rebuilt, and with the increase in the manufacturing plants of all kinds the people have more ready money than ever before. Wages have been increased in some cases nearly a hundred per cent, and in consequence the people are adopting a higher plane of living. Factories of many kinds are being planned and built, some under the direct supervision of American, English, Swedish and other engineers. The choice of these men, who will largely determine the equipment that will be adopted, is often dependent on the source of the capital furnished for the factory.

One mistake that is being made in the published descriptions of the Russian conditions is to speak of the changes that are taking place as "rapid." Nothing with which the people of Russia have to do is rapid—quite the reverse. The introduction of modern methods of manufacture, the use of labor-saving machinery, the adoption of comforts such as we have in America and a voice in their own government will all be matters of education, and they will be slow; but they are all coming. D. E. J.

* * *

The smoother the point of the diamond used for truing diamond wheels, the smoother will be the finish on the work. Don't think of the diamond as a means of sharpening the wheel, but rather as a means for correcting inequalities of the surface.—*Grits and Grinds.*

WESTINGHOUSE RIFLE BARREL DRILLING AND REAMING MACHINES

Both the drilling and reaming machine have capacity for handling twelve rifle barrels simultaneously and the work is held in a vertical position on both machines. This is the means of securing several important advantages, among which particular attention is called to economy of floor space. One of these twelve-spindle machines occupies the same amount of room as an ordinary rifle barrel drilling or reaming machine which works on two barrels simultaneously. Each spindle on the drilling machine is driven by an independent variable-speed motor, and an automatic electric switch provides for stopping the spindle should a drill stick or become dull. On the reaming machine feed is provided by counterweights, so that the rate of feed may be automatically adjusted to accommodate varying conditions in the size of bore, hardness of material, etc.

A radical departure from the conventional method of drilling and reaming rifle barrels has been made in the machines shown in Figs. 1 and 2, which have been designed by the New England Westinghouse Co., and are now at work in its East Springfield, Mass., plant. These machines differ from standard rifle barrel drilling and reaming machines in several important respects: First, they are designed to handle the barrels vertically instead of horizontally; second, twelve instead of two barrels are handled by each machine; third, each spindle on the barrel drilling machine is driven by a separate variable-speed motor; fourth, one machine occupies exactly the same floor space as the standard machine, which has a capacity for only two instead of twelve barrels; fifth, on the drilling machine an automatic electric switch instead of a mechanically operated clutch is provided for stopping the machine should a drill stick or become dull; and sixth, on the barrel reaming machine, the feed is by counterweights instead of a positive screw, thus automatically adjusting the rate of feed to suit varying conditions in the size of bore and hardness of metal.

Fig. 1. Westinghouse Rifle Barrel Drilling Machine that works on Twelve Barrels simultaneously

Rifle Barrel Drilling Machine

Reference to Fig. 1 will show that the rifle barrel drilling machine consists of an upright frame standing on a base of rectangular section and carrying twelve individual units, comprising a variable-speed motor, headstock, tailstock, drill guide, carriage and controller, the controller being located at the rear of the machine. All these members, with the exception of the motor and headstock, are carried on twelve uprights. In the machine shown, these uprights are of square section, which in the later models now being built will be changed to circular section to facilitate machining and assembling.

In operation, the rifle barrel to be drilled is held in and rotated by the headstock, a female driving chuck or center with sharp projections contacting with the machined taper on the muzzle end of the barrel. This chuck is connected directly to the motor shaft. The lower center in the tailstock is held upward by a stiff spring, thus insuring that the barrel is always held up in the chuck with the same pressure, and at the same time providing for linear expansion of the barrel due to heating while it is being drilled. The carriage is furnished with the standard type of oil-tube barrel drill and is fed upward by a lead-screw that receives power from the motor through a train of gears, worms and worm-wheels.

The oil is pumped up through the drill from an oil "line" in which the pressure registers about 800 pounds per square inch. The oil and chips pass down through the exterior flute in the drill and shank, and are carried off through a "by-pass" pipe which is part of the tailstock casting. This pipe extends to the rear of the machine and empties into a trough in which the chips are separated from the oil, which returns to the pump.

Each spindle is automatically stopped when the drill breaks through at the muzzle end of the barrel by a dog which operates the starting and stopping handle. An interesting feature in connection with this machine, which eliminates the splashing of oil when the drill breaks through, is a "by-pass" arrangement consisting of angular holes in the lower section of the headstock casting. This "by-pass" conveys oil from the drill to a pipe, which, in turn, carries it to a trough behind the machine. In this way, the machine is kept clean and free from oil.

Another feature, which relates more particularly to the electrical equipment, is the provision made for stopping the machine automatically, should the drill become dull or stick and thus consume more power than would ordinarily be required. This consists of an electric switch, comprising an overload coil which is connected in series with the armature, and is so arranged that any excess current passing through the armature will operate the coil and through it the switch, thus automatically stopping the machine. This overload coil can be very accurately adjusted to suit conditions of steel, etc. A starting rheostat is also provided which enables work speeds varying from 1200 to 2400 revolutions per minute to be obtained.

Fig. 2. Westinghouse Twelve-spindle Rifle Barrel Reaming Machine

This vertical rifle barrel drilling machine has been found to combine a number of valuable features. In the first place, it brings the line of action of gravity parallel with the axis of the drill, which tends to produce a truer hole and also helps to keep the drill clear of chips. In addition, it permits of the arrangement of a greater number of spindles in such a position that one man can easily attend to twelve spindles, enabling him to secure a very high rate of production. The other advantages previously enumerated clearly prove that this machine represents a considerable advance in the art of deep-hole drilling.

Rifle Barrel Reaming Machine

In the rifle barrel reaming machine shown in Fig. 2, advantage is also taken of the vertical principle of handling the work. Reaming on vertical machines comprises several important advantages over the horizontal method. In the first place, twelve spindles occupy exactly the same floor space as two spindles of a horizontal machine, and present the spindles in compact form, so that they can be attended to by one operator. In the second place, lubrication of the reamer is more easily accomplished, resulting in the production of holes free from rings and other defects.

There are several other advantages incorporated in this machine, among which are the following: First, the barrels are swung from universal joints, enabling the reamers to follow the drilled holes accurately. Second, the feed is by counterweights—not positive—so that it automatically adjusts itself to agree with the amount of work being done by the reamers. For instance, if there is more material to be reamed out of a hole than is normally the case, the machine will feed more slowly; and if the reamer strikes a hard spot in the barrel, the feed will slow up to accommodate itself to this condition. Third, the machine can be used either for push or pull reaming. This is accomplished by changing the direction of driving rotation of the belt on the cone pulley at the left-hand end of the machine, and by changing the location of the counterweights.

The feed for the reamers, as previously mentioned, is obtained by means of counterweights which are placed on crossheads or at opposite ends of the cables, depending upon whether the push or pull method is being used. These cables run over pulleys that are mounted on friction clutches so arranged that they can be made to work in either direction. The weights can also be adjusted to give any rate of feed that is found most satisfactory for the steel being machined and the amount of material being removed. All twelve spindles are driven from one longitudinal shaft running the entire length of the machine, which, in turn, is operated from a countershaft located on the floor.

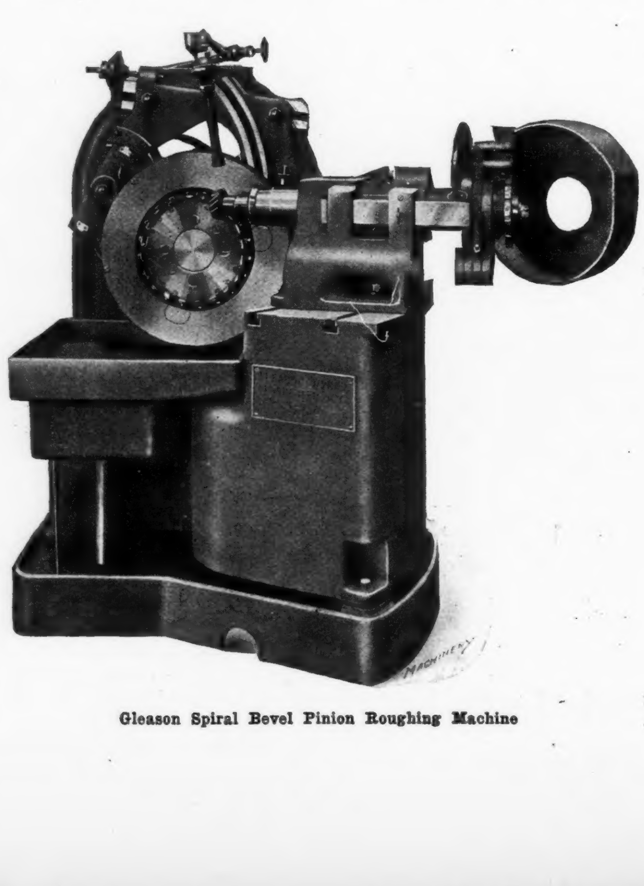
GLEASON SPIRAL BEVEL PINION ROUGHER

The standard Gleason spiral bevel gear generator is adapted for roughing and finishing gears of this type; but manufacturers of spiral bevel gears in quantity found need for a machine to rough out their pinions cheaper and faster than could be done on the regular finishing machine; and to meet this requirement the Gleason Works, Rochester, N. Y., have brought out the spiral type bevel pinion rougher which is illustrated and described herewith. Pinions roughed out on this machine are finished on the standard spiral bevel gear generator illustrated and described in the April, 1914, number of MACHINERY.

This pinion roughing machine is universal, *i. e.*, it is adapted for roughing either right- or left-hand spiral work, and it is fully automatic in operation. The construction is simple, making it easy to oil and adjust all parts. The positive index mechanism is actuated by the generating roll of the work-spindle; and for spacing teeth a notched dial is used, which has the required number of divisions. A cam mounted directly on the cutter sleeve drives the positive feed. The cutter is driven through a pair of internal gears, the driving pinion being integral with the pulley shaft. All other drives, including the pump drive, are taken from this shaft; all bearings are furnished with ample oiling facilities and the gears are thoroughly guarded.

The cutters used on the machine are of the same type as those used on the finishing machine and are interchangeable from one machine to the other. Adjustments for setting to the required spiral angle can be easily and quickly made, and the cutter is set permanently to the root angle and needs to be adjusted only as it wears or when a new cutter is required. The same mandrels are used on both roughing and finishing machines and, like the cutters, they are interchangeable. Attachments furnished with the machine include one index dial, one set of feed change-gears, one cutter gage, one oil pump and connections, one countershaft and the necessary wrenches for making all adjustments.

The principal dimensions of this machine are as follows:



Gleason Spiral Bevel Pinion Roughing Machine

longest cone distance of any gear that can be cut, 7⅝ inches; shortest cone distance of any gear that can be cut, 0; extreme ratio of any bevel pinion, 8 to 1; maximum pitch angle, 26 degrees, 34 minutes; minimum pitch angle, 7 degrees, 7 minutes; greatest pitch diameter of 8 to 1 ratio, 1⅞ inch; greatest pitch diameter of 2 to 1 ratio, 6½ inches; maximum diametral pitch, 2½; longest face, 1/3 cone distance; cutter speed, 130 feet per minute; fastest time in which one tooth can be cut, 19 seconds; slowest time in which one tooth can be cut, 90 seconds; diameter of driving pulley, 16 inches; width of driving belt, 4 inches; diameter of tight and loose pulleys, 12 inches; speed of countershaft, 300 R. P. M.; taper hole in spindle, No. 14 B. & S.; horsepower required to drive machine, 5; floor space occupied, 53 by 58 inches; height of machine, 60¾ inches; and net weight, approximately 5000 pounds.

OLIVER SAWING, FILING AND LAPPING MACHINE

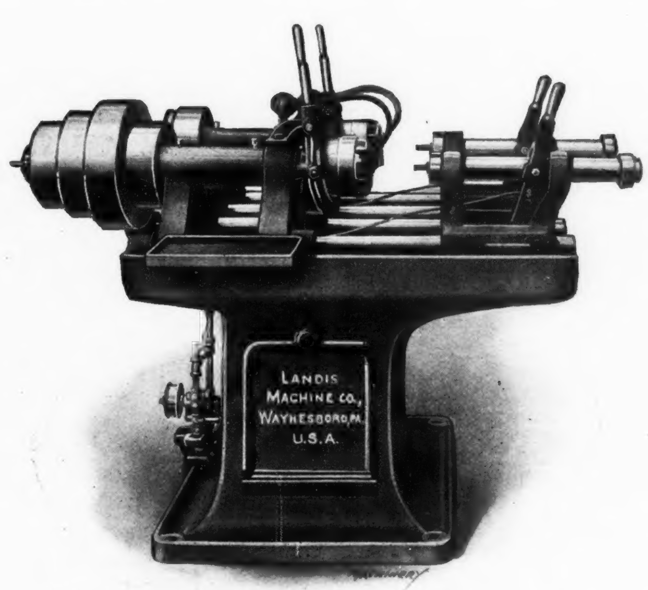
In the December, 1915, number of MACHINERY, a description was published of a sawing, filing and lapping machine which had just been placed on the market by the Oliver Instrument Co., 1168 Cass Ave., Detroit, Mich. Recently the same company has introduced an improved type of the same machine which provides for releasing the collet in the lower ram by means of a wrench similar to that used in the Jacobs drill chuck, instead of requiring the use of a spanner wrench, as was formerly the case. The design of the over-arm has also been improved by providing means for holding a saw in the upper ram, this being accomplished by the use of a clamp instead of a collet. A holder for files and oilstones has been devised in which any standard file can be used by cutting it off to suitable length. This makes it possible to use up the entire file, instead of merely working at one spot. This same holder can be adapted for receiving oilstones which are made in various shapes and sizes. An extra hold-down is furnished for use when the over-arm is not in place. Other features of the machine are the same as those described in the December, 1915, number of MACHINERY.

LANDIS SET-SCREW THREADING MACHINE

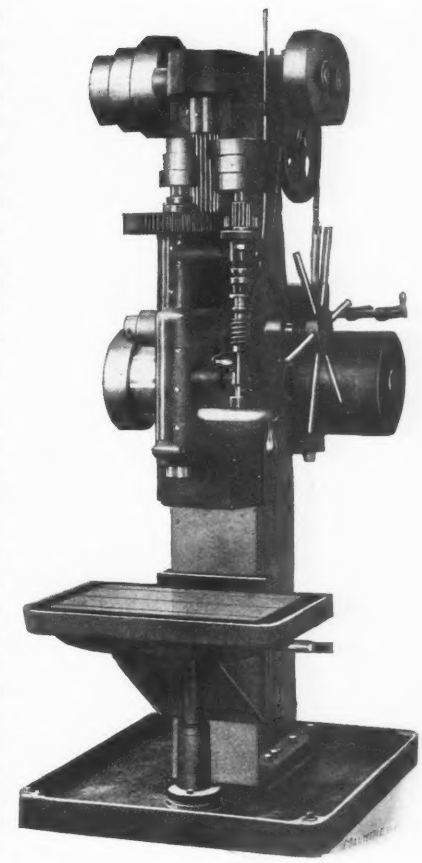
The Landis Machine Co., Waynesboro, Pa., has recently placed on the market threading machines equipped with special carriages for threading hollow safety set-screws. While these machines were primarily designed for this purpose, they may be employed for threading stock where there is a continuous thread and a similar method of holding. The carriages proper are stationary and support two spindles which have a free horizontal movement. These spindles are brought to the threading die-heads by means of weights which are attached by chains to levers operating the spindles. These weights exercise a continuous force upon the spindles in the direction of the die-heads, making it unnecessary for the operator to feed the stock forward for the threading operation.

The heads of the spindles are bored and fitted with mandrels for holding the set-screws, and a collar is placed on the rear of each spindle, making it adjustable for cutting any desired length of thread. For the threading operation, the set-screw is placed on the mandrel and the spindle automatically forces it into the die-head. When the screw is threaded, it remains in a tube which extends through the spindle from the face of the threading die-head to the rear of the machine. The subsequent threading of screws forces the finished pieces through the tube, where they drop into a receptacle placed at the rear of the machine.

These machines may also be used for threading standard bolts by attaching automatic opening and closing attachments for the die-heads. When standard bolts are threaded, the heads of the spindles on the carriages are fitted with bolt sockets for the various diameters within the range of the machine. These machines are equipped with Landis all-steel die-heads, which employ long-life chasers.



Landis Hollow Safety Set-screw Threading Machine



Moline Traversing-head Drilling Machine

MOLINE TRAVERSING-HEAD DRILLING MACHINE

The accompanying illustration shows a single-spindle traversing-head drilling machine which has recently been added to the line of machines built by the Moline Tool Co., Moline, Ill. Instead of mounting the spindle in a quill which is fed by a rack and pinion, the entire head is traversed by a double rack and pinion, the spindle running in long bronze bushings with means of compensating for wear. Attention is also called to the fact that, instead of drawing the spindle through the gear and subjecting the keys to considerable strain while traversing, the spindle driving gear is mounted directly on the spindle and traversed along a wide faced pinion which is supported on a shaft that runs in bronze-bushed bearings. This long pinion is driven by steel and bronze spiral gearing.

Between the spiral pinion and cone pulley shaft there are change-gears by which practically any range of speeds can be obtained. As shown, the machine is equipped with belt feed; but gear-box feed can be provided if desired. The spindle may be furnished with a short nose and a hollow to accommodate a knock-out rod; or it may be provided with the nose extending far enough out from the bearings to afford space for a knock-out slot. The spindle nose may also be threaded for a chuck if desired. The countershaft is mounted on the column; and the machine is equipped with a pump and lubricant pipe as part of the regular equipment.

The principal dimensions of this drilling machine are as follows: distance from center of spindle to face of column,

10 inches; maximum distance from table to spindle, 34 inches; maximum distance from spindle to floor plate (when provided), 46 inches; working face of table, 15 by 24 inches; number of T-slots in table, 3; maximum vertical adjustment of table, 15 inches; maximum travel of head, 18 inches; diameter of spindle in lower bearing, 2 15/16 inches; size of tight and loose pulleys, 12 inches diameter by 5 inches face width; size of steps on cone pulley, 8, 10 and 12 inches diameter by 3 inches face width; countershaft speed, 500 R. P. M.; available speeds with two sets of change-gears, from 20 to 200 revolutions per minute.

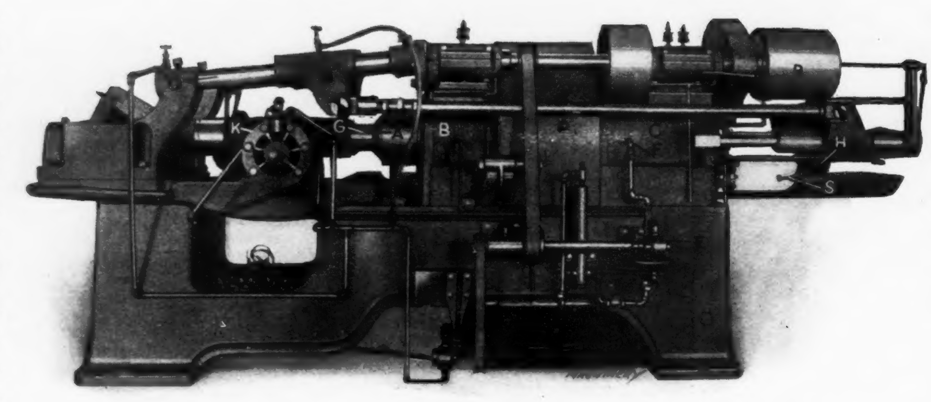


Fig. 1. Warren Hydraulic Lathe for External Machining Operations on Shell Forgings

WARREN HYDRAULIC LATHE

This machine is a rather interesting modification of the hydraulic lathes already built by the Lombard Governor Co., Ashland, Mass., for the rapid production of 3-, 5- and 9-inch high-explosive shells. As is the case with previous machines, spindle *A*, that is 9 inches in diameter and about 4 feet long, is mounted in two long bearings *B* and *C*, which are cast integral with frame *D* of the machine. The rear end of spindle *A* is enlarged to 10 inches in diameter and forms a revolving piston in rear bearing *C*.

Oil under pressure is supplied by small pump *E*, through pipe *F*, to act against the revolving piston at the end of spindle *A* in such a way as to hold the spindle rigidly as regards axial motion without interfering in any way with its rotation; and this body of oil at all times takes the whole thrust of the spindle. A needle valve provides convenient means for permitting oil to enter slowly behind the end of spindle *A*, and this moves the whole spindle forward; in this way an accurate and infinitely adjustable axial feed for the spindle is provided. A tool steel arbor *G* extends from the front end of the spindle into the shell forging; and expanding pins in the arbor, which are set out by the hydraulic diaphragm *H*, provide a satisfactory method of clamping the forging firmly on the arbor.

Two hydraulic turning tool-holders on opposite sides of the arbor, one of which is shown at *K*, carry tools 1 inch wide and 2 inches deep, which are used for roughing out the cylindrical portion of the shell. Drill *L* and facing tools *M* are mounted in a heavy swinging arm (see Fig. 2), which can be thrown down and locked central with the main spindle of the machine. These tools are used in this particular shell, which is the Italian, for perforating the closed end with a 2¼-inch hole and facing this end to length. For the purpose of cutting off excess metal at the open end of the forging, a traveling cutting-off tool-holder *N* is provided, that moves on inclined ways *O*, being driven from the main spindle of the machine by heavy connecting rods *P*. In carriage *N* is mounted a heavy parting tool. It is evident that as main spindle *A* moves forward, carriage *N* will move at the same rate, but on account of inclined ways *O* the cutting-off tool will have a component motion downward which will force the tool into the forging and finally result in cutting off the excess metal.

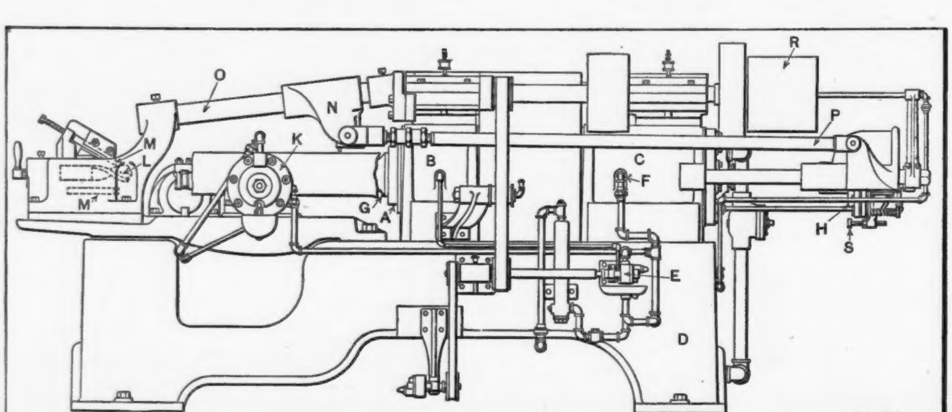


Fig. 2. Warren Hydraulic Lathe, showing Drill and End Facing Tools

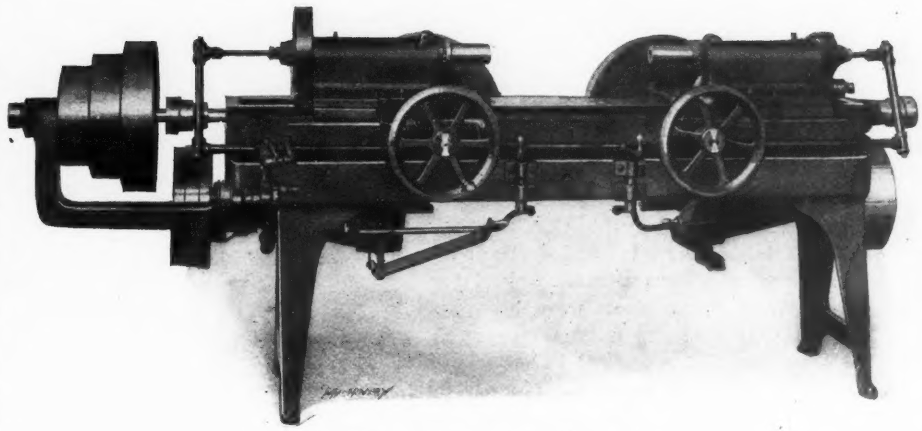
In operating the machine, spindle *A* is started in its backward position, the shell forging having been firmly clamped on the arbor — an operation requiring less than ten seconds. The spindle is started into rotation by a powerful hydraulic clutch *R*, which is operated instantly by a small valve, and then by opening another valve the turning tools mounted in holders *K* are fed into the work. As soon as this has been accomplished, the forward axial movement of spindle *A* begins; then the turning tools which divide the length of the shell into halves begin to remove metal from the outside. Very soon the cutting-off tool begins to penetrate the forging, and these three tools continue to work until the front end of the forging strikes drill *L*. Then the rate of feed is slightly reduced as the drill cuts through the closed end and the facing tools *M* finish this surface, which is 6 inches in diameter, to the correct length. When spindle *A* reaches its extreme forward position an adjustable stop *S* strikes an automatic reversing valve and the spindle immediately returns to its initial position, having finished the following operations on the forging: (1) Rough-turning the outside 22 inches long; (2) cutting off the open end to length; (3) perforating the closed end with a 2¼-inch hole; (4) facing the closed end to dimensions.

It will be observed that all these operations are taking place continuously, and at one time six tools are cutting simultaneously. The metal in Italian shell forgings is exceedingly tough and hard, and only the very best high-speed steel or stellite tool points will stand up for more than one or two shells without resharpening, but the economy of production of this hydraulic lathe is said to be most remarkable. In a test, all of the operations described were performed within a time interval of ten minutes and forty seconds, which is one-third of the shortest time required on ordinary power feed machines, such as heavy lathes, drills and cutting-off machines, for doing the same work. About thirty horsepower is required to drive one of these lathes. The operating oil pressure is in the neighborhood of 200 pounds per square inch. Cutting compound is supplied to all the tools, and the machine as a whole, including the extended arbor *G*, is so stiff that it operates almost without vibration and does not require any special foundation. Four of these lathes have been furnished to the Driggs, Seabury Ordnance Co., Sharon, Pa.

MOLINE DUPLEX DRILLING MACHINE

One of the latest additions to the line of machinery built by the Moline Tool Co., Moline, Ill., is the duplex drilling machine shown in the accompanying illustration. This machine has a capacity for driving drills up to 1 inch in diameter, and when so desired, gears on the machine can be changed to provide for running one spindle faster

than the other when it is desired to use two drills of different sizes. Both heads are driven from a central driving shaft; and the bed is cast in such a way that the top is solid at the center to protect the mechanism from chips; an oil tank is also cast integral with the bed. Each spindle is provided with three changes of feed which are independent of each other, and three changes of speed are available. The machine is equipped complete with a pump and piping for connection with the oil tank in the bed.


Duplex Drilling Machine built by Moline Tool Co.

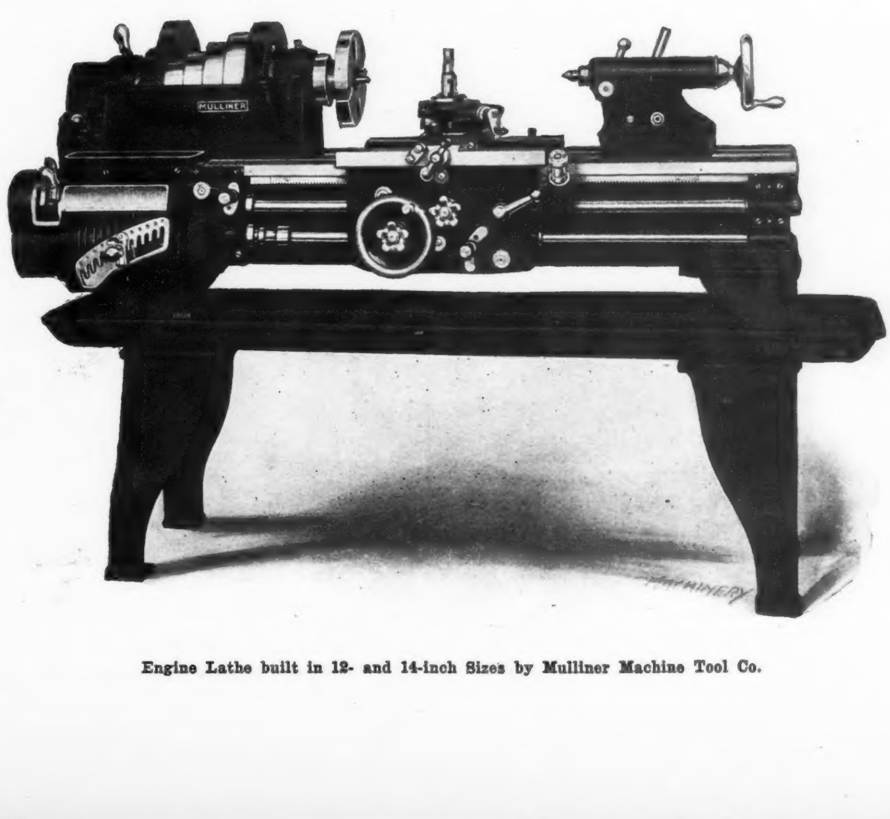
The principal dimensions of this machine are as follows: length of bed, 7 feet; minimum distance between spindles, 4 inches; maximum distance between spindles, 30 inches; bore of spindles, No. 4 Morse taper; distance from spindles to bed, 6 inches; width of bed, 10 inches; and capacity, for driving drills up to 1 inch in diameter.

MULLINER ENGINE LATHE

The Mulliner Machine Tool Co., Inc., 541 S. Clinton St., Syracuse, N. Y., is now manufacturing 12- and 14-inch sizes of the quick-change gear lathe shown in the accompanying illustration. The bed is ribbed transversely with heavy double-walled cross girths, and the bed castings are made in a way which produces a hard, close-grained metal. This provides a harder metal on the shears than in the carriage bearings, so that wear is largely confined to the carriage where compensation can be made.

The headstock spindle bearings are provided with means of compensating for wear; and the front and rear journals are adjustable independently of each other. These bearings are of the ring-oiling type and receive lubricant from large oil reservoirs. The spindle is made from a crucible steel forging and is accurately ground to size. The double-walled construction has been adopted for the apron in order to take advantage of the outboard bearings provided for all studs and shafts. Full surface contact is provided between the swivel and bottom slide of the compound rest; and the rest is clamped to the cross-slide by two bolts. Full length tapered gibs with end screw adjustment are furnished for slides of both the cross and compound rests.

Cone gears of the quick-change gear mechanism are cut with improved Brown & Sharpe 20-degree involute cutters, which form a pointed tooth that is slightly rounded at the top. This is a very satisfactory form of tooth to use in a tumbler gear mechanism, as it permits of instantaneous engagement of gears without clashing. The quick-change gear mechanism gives thirty-seven changes of threads and feeds, which are shown on an index chart mounted on the quick-change gear-box. In addition, provision is made for applying extra change-gears by means of an auxiliary quadrant located at the end of the bed, which carries gears connecting the head with the quick-change gear mechanism. This arrangement permits the use of such extra change-gears as are necessary to cut all special or metric threads.



Engine Lathe built in 12- and 14-inch Sizes by Mulliner Machine Tool Co.

The regular equipment furnished with these lathes includes compound rest, steadyrest, thread chasing dial, large and small faceplates, a countershaft and the necessary wrenches for making all adjustments. The principal dimensions of the 12-inch lathe are: swing over bed, 12¾ inches; swing over carriage, 7½ inches; ratio of gearing in head, 10 to 1; cone pulley steps, 2⅞, 4½, 6⅛ and 7¾ inches in diameter by 1¾ inch face width; diameter of hole through spindle, 15/16 inch; range for screw cutting, 1½ to 80 threads per inch; range of feeds, 6 to 320 per inch; capacity between centers for 6-foot bed, 40 inches; and net weight of machine with 5-foot bed, 1990 pounds. The dimensions of the 14-inch lathe which differ from those of the 12-inch machine are as follows: swing over bed, 14¼ inches; swing over carriage, 8¾ inches; ratio of gearing in head, 8½ to 1; cone pulley steps, 3⅝, 5¼, 6⅞ and 8½ inches in diameter by 2 inches face width; diameter of hole through spindle, 1 inch; capacity between centers for 6-foot bed, 36 inches; and net weight of machine with 5-foot bed, 2100 pounds.

G. E. TIME-LIMIT OVERLOAD RELAY

The single-pole time-limit circuit closing overload relay illustrated and described herewith is of simple and rugged construction. It is particularly applicable to those systems where extreme accuracy in timing is required for tripping two or more air or oil circuit breakers selectively. Operating or characteristic curves for the various time-current settings are entirely separate and distinct at even the heaviest overloads and never become instantaneous; and heaviest overloads do not disturb the form of curve nor cause vibration of the moving parts. The relay operates within a period of time which varies inversely with the lower current values and approaches a definite minimum time for the higher current values. Consequently, the relay will do the work ordinarily required of time-limit relays

that operate within a definite time and those that operate in a time that is reduced as the current values increase.

The relay is designed for use in the secondary of current transformers. The normal load rating is five amperes; but by means of a current tap plate and a metal tap plug portions of the relay winding are cut out so that the relay may be set to operate at four, five, six, eight and ten amperes. Positive operation is obtained at any setting throughout this range. The contacts are closed on overload by rotation of a disk actuated by a U-shaped driving magnet with shading coils on the pole pieces. No tripping current is carried through the revolving parts. When the contacts have been closed they are firmly held in that position, until tripping occurs, by the armature of a holding coil connected in series with the contacts, the trip coil of the air or oil circuit breaker and an auxiliary switch which opens when the breaker is tripped. This insures current on the trip coil continuously until the circuit breaker opens, and prevents flashing at the contacts, which, as an additional precaution, are of high heat-resisting metal and non-corrosive, making them practically indestructible. The current closing capacity is extremely high for a relay of this type and ample for directly tripping any one circuit breaker made by the General Electric Co.

Temperature errors are minimized by a compensating device which is part of the relay; and bearings are of the jewel type used in G. E. watthour meters, so that the friction is small and will not vary. The values given in vertical columns 1 to 10 on the index plate are the time delays which will be obtained with different degrees of overload represented in the "Times

G. E. Type I, Form A Time-limit Overload Relay

Current Tap Setting" column at the extreme right and left sides of the index plate. The factors appearing in the "Times Current Tap Setting" columns, when multiplied by the current tap settings, represent actual secondary current values.

To obtain a given current setting it is only necessary to insert the metal tap plug in the current tap plate at the desired current marking. Time settings are obtained by moving a small lever in front and near the top of the relay, to the graduation mark representing the column in which the desired time appears. The relay is being furnished in two styles, for 25- and 60-cycle circuits, respectively. The principle of operation and inherent characteristics are the same in both, and the relays themselves differ only in slight details of construction. This relay is known as Type I, Form A and is being manufactured by the General Electric Co., Schenectady, N. Y.

GLOBE COLLET CHUCK

The collet chuck shown in the accompanying illustrations takes the place of the usual type of draw-in collet chucks made for use on engine lathes. Fig. 1 shows the parts of this chuck, and in Fig. 2 the headstock of an engine lathe is shown with the collet chuck in place in the spindle. It will be evident from these illustrations that instead of the operator's having to go to the rear of the lathe to tighten or release the collet, he is able to do this at the nose of the spindle, making it unnecessary to leave the regular operating position. This saves a considerable amount of time. It will be seen that this chuck takes the place of a center in the spindle; on small lathes a No. 3 Morse taper center is usually furnished, and on lathes swinging from 16 to 20 inches a No. 4 Morse taper is furnished. The body of the chuck, as well as the nose-piece, is made of steel which is heat-treated and ground; and the collet is made of tool steel that is tempered in oil, and it is split back about three-quarters of the way from both ends, so that when tightened on a bar by means of the handwheel the chuck grips for the full length of the collet.

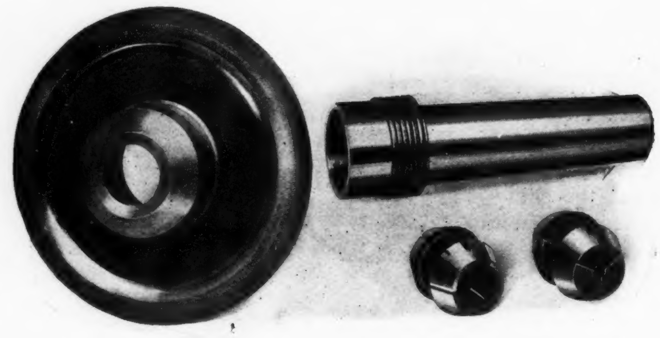


Fig. 1. Parts of Collet Chuck made by Globe Engineering Co.

In order to attach this collet chuck to the lathe it is necessary to remove the spindle center and substitute the taper end of the chuck. Next remove the nose-piece on which the handwheel is mounted and place the collet in the body of the chuck, and after this has been done, screw the nose-piece back into place. These collet chucks are made in two sizes by the Globe Engineering Co., 412 Traction Bldg., Cincinnati, Ohio. The principal dimensions of the No. 0 chuck are: taper of shank, No. 3 Morse; capacity for round stock, up to 5/8 inch in diameter; capacity for hexagonal stock, up to 1/2 inch; capacity for square stock, up to 7/16 inch; diameter of handwheel, 5 inches; and distance chuck projects beyond spindle, 2 1/4 inches. The principal dimensions of the No. 1 collet chuck are: taper of shank, No. 4 Morse; capacity for round stock, up to 3/4 inch in diameter; capacity for hexagonal stock, up to 5/8 inch; capacity for square stock, up to 9/16 inch; diameter of handwheel, 6 inches; and distance chuck projects beyond lathe spindle, 2 1/2 inches.

PORTER-CABLE TAPER ATTACHMENT

The Porter-Cable Machine Co., Syracuse, N. Y., has developed the taper attachment illustrated and described herewith, for use on its manufacturing lathe. Like the machine for use on which it was developed, this attachment is essentially a manufacturing device, and consists of a double cross-slide with the upper tool-rest H controlled by a hand screw, and the lower auxiliary slide E controlled by the taper form or wedge A.

Fig. 2. Globe Collet Chuck in Use on Lathe

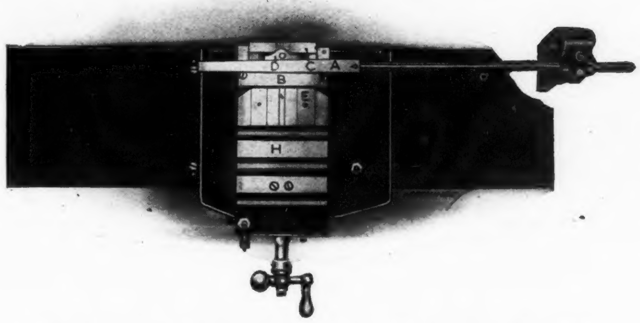


Fig. 1. Taper Attachment for Porter-Cable Manufacturing Lathe

Auxiliary slide *E* has a projecting portion *C* which is machined to form a seat for swivel shoe *D* that bears against the inclined surface of wedge *A*. The straight side or base of this wedge bears against block *B*, which is rigidly fastened to the carriage; and there is a concealed compression spring which tends to force slide *E* toward the operator so that swivel block *D* is always in contact with wedge *A*. It will be noted that this is the same direction as the thrust of the work against the tool, so that a smooth, uniform cut and true taper is obtained on the work; and duplicate pieces can be produced indefinitely.

A bracket *F* is provided, which is bolted to the end of the lathe and forms a clamp for adjustable rod *G*. Wedge *A* and bearing blocks *B* and *D* are hardened and ground; and the substitution of one wedge for another of different taper only takes a moment, as the taper block *A* is attached to rod *G* by a single cross-pin. This taper attachment is self-contained in the carriage and is very rigid, all possibility of spring being eliminated. Wedges may be made of any desired taper for the work; and in making these wedges advantage should be taken of the simple expedient of milling a groove across the small end of the wedge, as shown in Fig. 2, to form a point which can be measured with the same accuracy as the large end of the wedge.

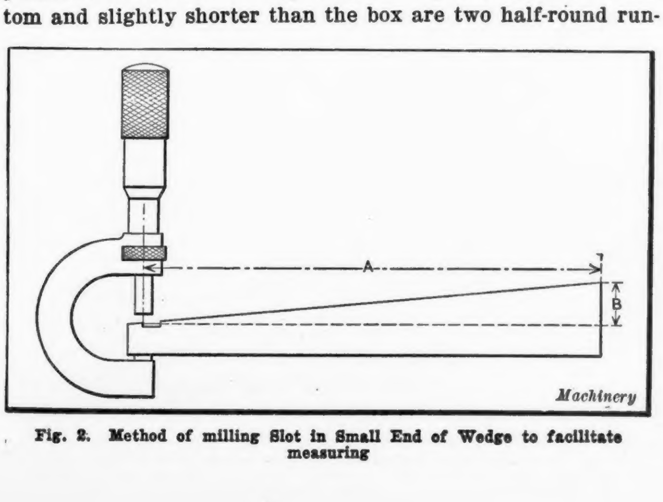


Fig. 2. Method of milling Slot in Small End of Wedge to facilitate measuring

NEW BRITAIN STACKING TOTE BOXES

Numerous improved features have been incorporated in the New Britain stacking tote boxes which are made from No. 16 gage steel and electrically welded throughout, no rivets being used. Handles are made of No. 14 gage stock, folded double and punched to afford hook hold for dragging the boxes along the floor. It is believed the size adopted (20 by 12 by 6 inches) will best meet average requirements, being in length and capacity about the limit for comfortable one-man handling. The sides slope inward just enough to provide support for the box above and are folded onto the ends. Yet the deviation of the sides from square is so small that rectangular work can be packed in as conveniently as irregular pieces. A ¾-inch selvage around the edge of the box increases its stiffness.

The ends extend 1 inch above the sides and are folded over onto the selvaged edge of the sides where the latter lap onto the ends; these raised ends are bent outward sufficiently to permit the box above to slip between. Spot-welded to the bottom and slightly shorter than the box are two half-round runners. These are carefully beveled on the ends and so placed that, when the box is in the stacking position, they are in contact with the edges of the box below, thus opposing any tendency of the sides to spring in under heavy weights. The upper corners of the ends are cut off at a 45-degree angle, and embossed pieces are spot-welded to the lower corners of the ends parallel with the upper corners and in such a position as to act as guides in bringing the box to the stacking position. These guides, in conjunction with the runners, also serve to prevent any sidewise shifting of the boxes while being trucked.

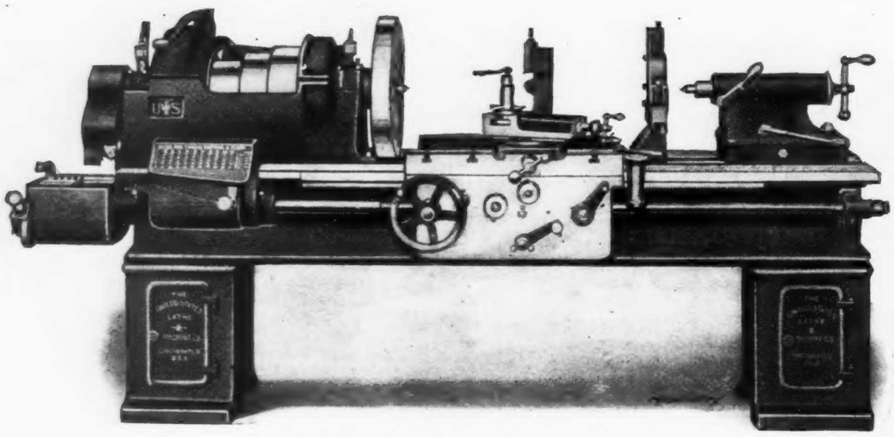
In dragging a box over the floor these runners present only line friction and remove wear and tear from the bottom of the box, thus making for longer life. As a result of this feature, the New Britain stacking box lends itself to storage in racks better than the average, because it will slip into and out of the rack with greater ease. Owing to the small bearing surface and the firmness of the stacking feature, it has been found that a stack of five or six loaded boxes can be dragged along the floor with remarkably slight effort. By reason of the raised ends generous space is provided above the handle for a card holder, in which position it more readily indicates the contents of the box and is less likely to become soiled.

No more care is required to stack these boxes than to nest ordinary nesting boxes, since it is only necessary to bring one box approximately over another and let it drop. The raised ends and embossed guides automatically bring it to its proper position. The boxes, when stacked, are securely held and can be trucked any distance over uneven floors without danger. In fact, in order to become unstacked, a box must be jarred or raised up 1 inch; otherwise, it will settle back to its stacking position automatically. As further indicating the security of the stacking feature, a stack of ten boxes can be tilted to an angle of almost 45 degrees before buckling. These boxes are made by the New Britain Machine Co., New Britain, Conn.

New Britain Stacking Tote Boxes

UNITED STATES LATHE

In the September number of MACHINERY a description was published of the 20-inch lathe which had just been placed on the market by the United States Lathe & Machine Co., Cincinnati, Ohio. The machine referred to is equipped with a five-step cone pulley and single back-gears. Recently the same firm has brought out the machine shown in the accompanying illustration, which is of similar design except that it is driven by a three-step cone pulley and double back-gears. It will be seen that simplicity of design and strength of all parts are predominant features of this machine, which insure ease of operation and long life. The feature of having the quick-change gears locking downward, which was described in connection with the previous article, has also been applied on the present machine. The general features of construction are the same for both single and double back-geared lathes.

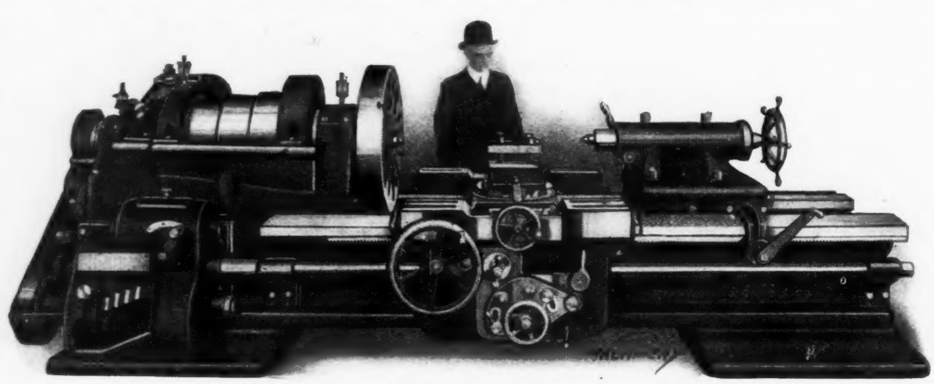


United States Double Back-geared Lathe

The principal dimensions are as follows: swing over bed, 20¾ inches; swing over rest, 12¼ inches; swing over carriage, 14¼ inches; maximum capacity between centers, 56 inches; hole through spindle, 1 9/16 inch diameter; diameter of tailstock spindle, 2⅜ inches; traverse of tailstock spindle, 9 inches; compound rest travel, 4¾ inches; capacity for thread cutting, from 1 to 32 threads per inch; and weight of lathe with eight-foot bed, 4600 pounds.

HOUSTON, STANWOOD & GAMBLE HEAVY-DUTY LATHE

The Houston, Stanwood & Gamble Co., Cincinnati, Ohio, is now building a 30-inch heavy-duty standard engine lathe which is illustrated and described herewith. This machine is driven by a three-step cone pulley and double back-gears which have ratios of 3.55 to 1 and 12.5 to 1. The cone pulley steps are 16.4, 18.2 and 20 inches in diameter by 6⅜ inches wide, and under the usual countershaft speeds of 243 and 129 revolutions per minute, eighteen changes of speed are obtained. These speeds are as follows: 8.3, 10.2, 12.7, 15.7, 19.4, 24, 29.5, 36.3, 45, 55.5, 68.7, 84.6, 105, 129, 159, 196, 243 and 300 revolutions per minute. The range for thread cutting is as follows: 14, 12, 11, 10, 9, 8, 7, 6, 5½, 5, 4½, 4, 3½, 3, 2¾, 2½, 2¼, 2, 1¾, 1½, 1⅜, 1¼, 1⅛ and 1 per inch. The available feeds are as follows: 56, 48, 44, 40, 36, 32, 28, 24, 22, 20, 18, 16, 14, 12, 11, 10, 9, 8, 7, 6, 5½, 5, 4½ and 4 per inch.



Heavy-duty Standard Engine Lathe built by Houston, Stanwood & Gamble

All gears used in this lathe are made of steel and the important bearings are bronze bushed. The front spindle bearing is 8 by 10 inches in size and the rear spindle bearing 4½ by 8 inches in size; a hole 2½ inches in diameter extends through the spindle, and a faceplate 30 inches in diameter is screwed onto the spindle nose. Centers used on this machine are No. 6 Morse taper. The tailstock is of the set-over type to provide for the performance of taper turning operations, and the tailstock spindle is 4¼ inches in diameter and it has a travel of 12 inches. Four bolts provide for clamping the tailstock, and attention is called to the fact that the rear bolts are as accessible as the front bolts. In addition to this method of clamping, the tailstock is held in position by a pawl fitting a rack cast in the bed midway between the vees. The front vee-bearing is of a broad, low-angle type, permitting the use of a gib at the front edge on the under side and affording a guide to the carriage of the same width as the vee. Both headstock and tailstock are carried on the rear vee.

The lead-screw is splined to act as a feed-rod, and the friction is liberally proportioned and controlled by a large handwheel. Double wall construction has been adopted for the apron. In addition to the type illustrated, this lathe can be furnished with a housing covering the entire top of the headstock to support a motor, where individual motor drive is employed; and owing to the increased power provided and the elimination of belt trouble, the use of motor drive is recommended. This lathe swings 30½ inches over the vees and 18¼ inches over the bridge; it is built with any length of bed up to 30 feet, and with a minimum length of bed the machine weighs approximately 18,000 pounds.

LIQUID RHEOSTATIC CONTROL FOR A. C. WOUND-ROTOR MOTORS

The extensive use of electric motor drive for hoists, dredges, and similar applications brought to the fore the necessity for a controller for large wound-rotor induction motors which would give wide and accurate speed variation, positive time limit acceleration, and allow the motor to run at reduced speeds for long periods. To meet these conditions the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., designed the liquid type of control which is illustrated in the accompanying halftone, Fig. 1.

A liquid controller consists essentially of a primary panel and a liquid rheostat. The primary panel is made up of mechanically interlocked magnetic contactors for starting, stopping, and reversing the motor; oil circuit breakers which entirely disconnect the motor from the line in the event of an overload; a fuse knife switch for pump motor; and a low-voltage relay for the protection of the operator and apparatus against voltage failure. The secondary control consists of a

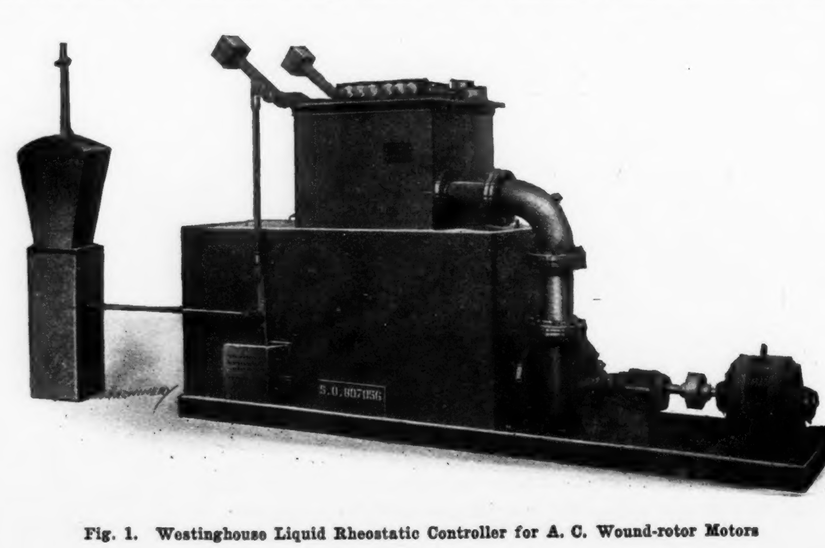


Fig. 1. Westinghouse Liquid Rheostatic Controller for A. C. Wound-rotor Motors

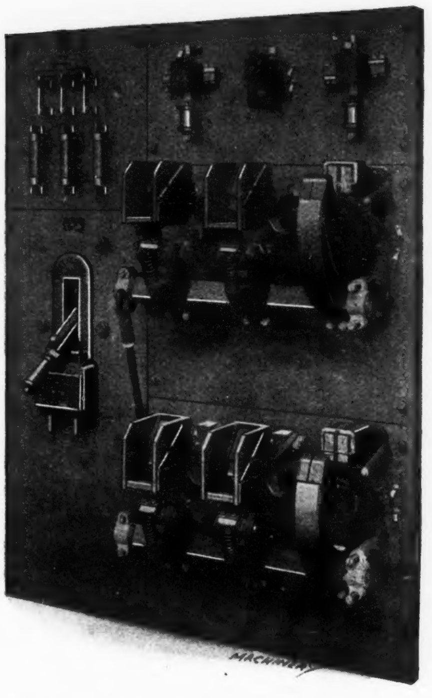


Fig. 2. Switchboard Panel used with Liquid Rheostat

liquid rheostat complete with brass or wrought-iron cooling coils for varying the resistance in the motor secondary, a pump and pump motor switch for the circulation of the electrolyte, and a master switch for the control of the equipment. For plugging service a single lever H-slot device and two overload relays are used. The two overload relays are mounted on the primary panel and protect the motor from overloads when running, but are short-circuited when plugging the motor. When operating under these conditions the circuit breaker is set to protect the motor against exceptional overloads and short circuits on the motor, but too high to trip out in ordinary plugging service.

In the type of control shown, the depth of the liquid in which the electrodes are immersed is varied. This principle insures smooth acceleration and close speed regulation of the motor, as an infinite number of steps can be obtained by gradually varying the depth of the liquid. It eliminates objectionable jerks and sudden strains in both the cable and equipment when starting loads of great inertia. The construction and operation of the control is so simple that even an inexperienced operator can obtain good results, and maintenance costs are low, since the electrodes are practically the only parts requiring renewal, and these infrequently. It is of especial value for heavy-duty reversing service when starting is frequent and the motor is run at reduced speeds. It is furnished for any primary voltage and frequency, and for either two- or three-phase.

As shown in Fig. 3, the three secondary phases of the motor are each connected to a set of electrodes suspended in the electrode tank. The operating lever is attached to an arm just above the master switch; and when the lever is in the "off" position the electrolyte, which is a solution of sodium carbonate (sal soda), is at its lowest level. When the operating lever is moved from the "off" position the contactors in the primary circuit are operated by the master switch and the weir raised. The electrolyte, which is circulated continuously by the pump, rises as the weir is raised; and this immerses the electrodes more, decreases the resistance in the rotor circuit, and speeds up the motor. By adjusting the position of the weir the resistance in the rotor circuit is changed and the speed of the motor regulated.

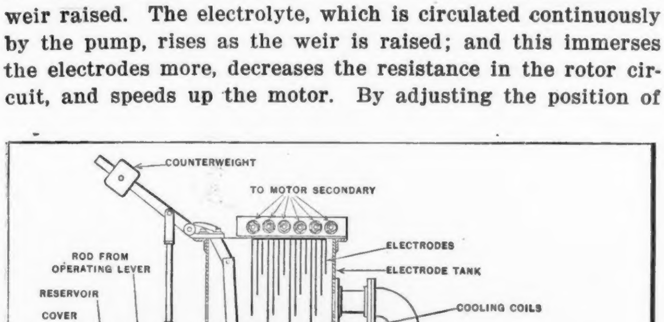


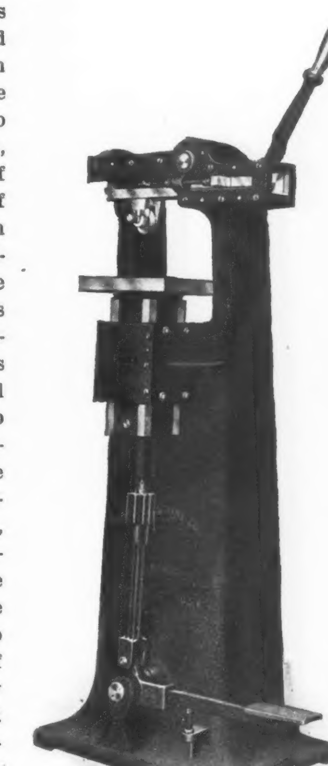
Fig. 3. Arrangement of Component Parts in Westinghouse Rheostatic Control for A. C. Wound-rotor Motors

A regulating valve in the pump discharge or intake pipe prevents the liquid from rising in the electrode tank at a rate greater than that for which the valve is adjusted. So the lever may be moved directly to the "full on" position while the liquid will rise at the rate determined by the valve setting. The weir, however, is of such a size and design that the electrolyte will flow through the lower compartment speedily enough to take care of plugging when that is practiced.

For plugging service the single lever H-slot device and the two overload relays afford a positive protection against the wrong operation of the lever. To prevent over-travel in hoist work, either single- or double-pole limit switches can be furnished; and when the hoists are used for lowering, an over-speed device is desirable. Cam limit switches form another means of protection, safeguarding against accidents due to carelessness on the part of the operator. These consist of a number of switches operated by means of cams mounted on a hexagonal shaft connected to the driving motor or the driven mechanism through a chain and sprocket or through a worm-gear.

MARTIN HAND MARKING MACHINE

The Martin Machine Co., Greenfield, Mass., has recently added to its line of marking machines the No. 6 hand-operated machine shown in the accompanying illustration. This is particularly adapted for use in marking trade names, sizes or patent marks on round or flat surfaces of such tools as drills, taps, dies, etc., and will mark any material in which an impression can be made. Attention is called to the simplicity of the design, which reduces probability of the machine getting out of order. Particular attention has been paid to providing ample strength in the handle and foot-treadle parts to avoid trouble from breakage. The pinion which moves the slide is made of steel and is exceptionally wide to insure strength and durability. Both table and slide are furnished with gibs to afford compensation for wear, and roller bearings are provided on the slide to reduce friction. The travel of the slide is regulated by a stop and screw, and the height of the table is adjusted by means of a screw and nut in order to increase or decrease the depth of marking.



Martin Hand Marking Machine for Drills, Taps, Dies, etc.

If the product to be marked has a flat surface, it is held in a suitable fixture mounted on the table, and by depressing the foot-treadle the table is raised to the desired height. The die held in a holder attached to the slide is then brought into contact with the work by means of a lever which forces the slide across to permit the die to roll the desired impression in the work. After completion of its stroke, the die is returned to the starting point by a spring in back of the holder. When marking round surfaces on taps, drills, etc., a flat die is attached to the slide and the work is allowed to roll on the table as the die comes into contact with it. Adjustments are provided when using round or flat dies so that the proper character on the die comes into contact with the work at a stated point; and screw stops govern the amount of travel after contact has been made, giving a clear cut from beginning

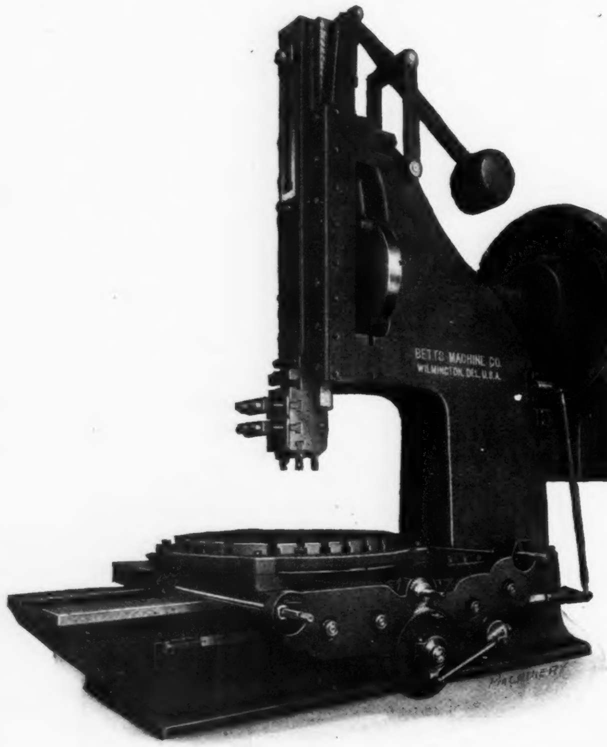
to end of the work. The principal dimensions of this machine are as follows: maximum travel of slide, 6 inches; maximum adjustment of table, 6 inches; floor space occupied, 20 by 20 inches; and weight of machine, 370 pounds.

BETTS CRANK SLOTTER

The Betts Machine Co., Wilmington, Del., has recently completed what is believed to be one of the largest crank-driven slotters ever built in this country, the machine having a maximum stroke of 30¾ inches. This slotter was built for installation at the plant of the Pennsylvania Steel Co., Steelton, Pa., which is a subsidiary of the Bethlehem Steel Co.

The fifteen-horsepower driving motor is bolted to the side of the frame, and in addition to the three to one variable-speed motor drive there are two geared speed changes. The cutter-bar has ten changes of speed and the return stroke is made at an increase of speed of 2¾ to 1. The bar is furnished with a vertically adjusted guide and relief tool apron.

The feeds are positive and self-acting in all directions, the feed motion taking place at the upper end of each stroke. Attention is called to the simplicity of the design and the convenience of operation, all handles, etc., being located so that the operator has full control of the machine from one position where he is able to watch the action of the cutting tool. The compound table has adjustment longitudinally and vertically and supports a revolving table which may be secured in any position by corner clamps. This table is graduated and so arranged that the worm may be disengaged for ready adjustment of the work. The principal dimensions of the machine are as follows: distance from frame to front of cutter-bar, 48 inches; capacity for slotting, to center of 100-inch circle; distance from table to under side of frame, 42 inches; diameter of round table, 54 inches; maximum longitudinal traverse, 64 inches; and maximum transverse traverse, 52 inches.



Crank Slotter with 30¾-inch Stroke built by Betts Machine Co.

ROCHESTER BALL THRUST BEARING

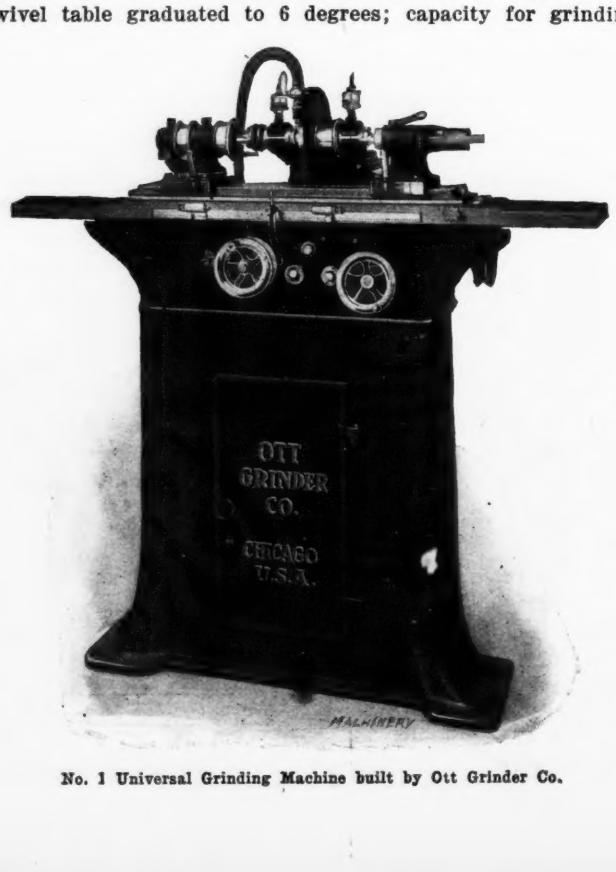
The Rochester Ball Bearing Co., Inc., 203 State St., Rochester, N. Y., has recently placed on the market a line of ball thrust bearings which possess certain individual features of design. Among these may be mentioned the fact that solid brass ball retainers are used, as this company's experience has led to the belief that the greatest strength and durability are obtained with this form of construction. These Rochester ball bearings are usually made with round race grooves, although V-groove bearings are regularly made for use on installations where the speed is high and the service required of bearings relatively light. Thrust bearings for heavy duty are made with the familiar form of self-aligning spherical seat washers. The accompanying illustration shows medium-weight bearings of large size, and in this connection it may be mentioned that retainers of small bearings are not scalloped.

Medium-weight Rochester Ball Thrust Bearing

OTT NO. 1 UNIVERSAL GRINDER

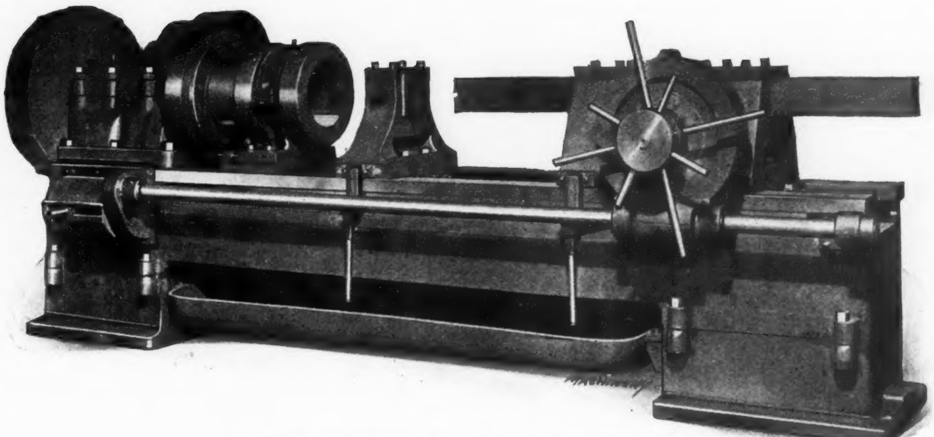
In the February, 1912, number of MACHINERY, mention was made of a No. 1 universal grinding machine which had just been placed on the market at that time by the Modern Tool Co., Erie, Pa. Recently, the Ott Grinder Co., 32 N. Clinton St., Chicago, Ill., has taken over the manufacturing rights on this machine, and before placing it on the market several noteworthy improvements have been made in the design. Among these the following may be mentioned: The swivel table adjusting mechanism has been simplified, allowing the table to be swung around at right angles to handle work for which such a setting is necessary. The design of the tailstock spindle clamping device and the headstock spindle bushing have also been improved. The internal fixture has been somewhat changed, and the work-rests are now provided with both vertical and horizontal adjustment and set-collars for maintaining constant dimensions on duplicate work. The design of the countershaft has also been somewhat simplified.

The principal dimensions of this machine are as follows: normal range, 5 by 16 inches; swing over table without water guards, 4 inches; swing over table water trough, 5½ inches; swivel table graduated to 6 degrees; capacity for grinding



No. 1 Universal Grinding Machine built by Ott Grinder Co.

tapers, up to 2½ inches per foot; diameter of wheel spindle, 1 inch; diameter of grinding wheel, 8 inches; face width of grinding wheels, ⅜ and ¾ inch; minimum reduction by power cross-feed, 0.0002 inch; maximum reduction by power cross-feed, 0.004 inch; available work speeds, 133, 178, 254 and 363 revolutions per minute; range of table speeds, from 34.5 to 121 inches per minute; horsepower required to drive machine, 2; floor space occupied, 31 by 68 inches; and net weight, 1400 pounds.



Heavy-duty Shell Boring Lathe built by W. & B. Douglas

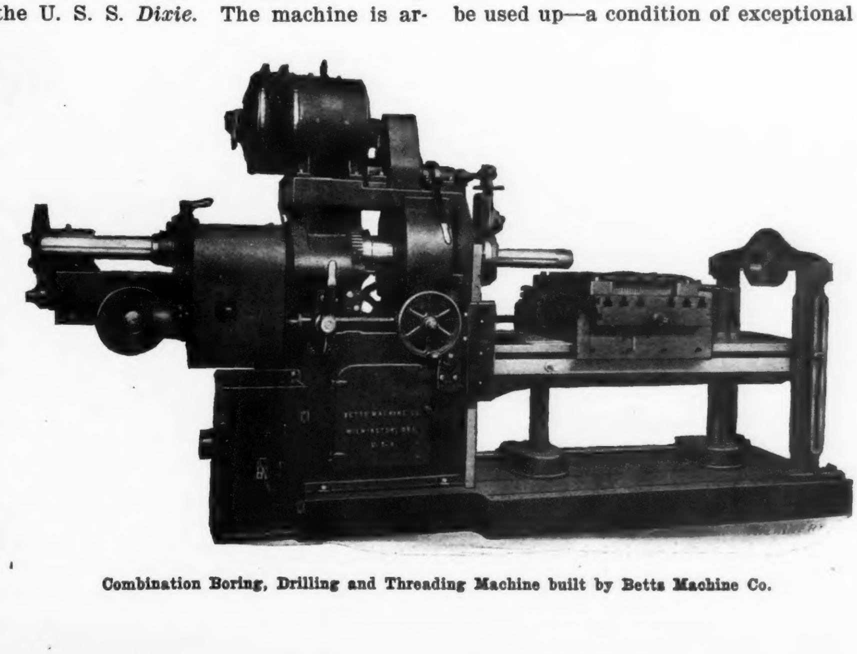
DOUGLAS HEAVY BORING LATHE

In the April number of MACHINERY mention was made of a heavy-duty lathe which had just been placed on the market by W. & B. Douglas, Middletown, Conn. This was a manufacturing machine primarily adapted for turning high-carbon steel forgings at maximum speed. Recently the same firm has introduced a heavy boring lathe for performing internal operations on shells from 8 to 12 inches in diameter. The bed, headstock and change-gear mechanism of both machines are similar, but the boring lathe is equipped with a pot chuck, special tailstock for operating a traversing boring-bar, and a steadyrest for supporting this bar, the arrangement being shown in the accompanying illustration.

The principal dimensions of the Douglas boring lathe are as follows: length of bed, 13 feet; swing over ways, 26½ inches; diameter of spindle, 6 inches; diameter of hole through spindle, 2 inches; dimensions of boring-bar, 5½ inches square by 74 inches long; maximum travel of boring-bar, 58 inches; maximum distance from faceplate to face of tailstock, 90 inches; maximum distance from faceplate to face of steadyrest, 81 inches; available feeds per revolution of spindle, 1/64, 1/32, 1/16 and 1/8 inch; ratio of gearing, 20 to 1; and size of cone pulley steps, 15 and 18 inches in diameter by 8 inches face width.

BETTS HORIZONTAL BORING, DRILLING AND THREADING MACHINE

The Betts Machine Co., Wilmington, Del., has recently completed a combination horizontal boring, drilling and threading machine for use on the U. S. S. *Dixie*. The machine is arranged with General Electric variable-speed motor drive, giving speeds from 7 to 260 revolutions per minute. The spindle is made of steel and is 3½ inches in diameter; it has a regular movement of 24 inches, and provision may be made for a traverse of 48 inches when required. Quick movement by hand is provided through a rack and pinion. The spindle may be driven in either direction and has a full bearing at all times through the cast-iron sleeve. The feeds are automatic, and six changes of feed are provided through gearing, covering a range from 1/128 to 9/32 inch per revolution; the spindle may be fed in either direction without reversing its rotation. It will be seen that the machine is equipped with a compound table, the bottom table being 6 feet long and elevated by two screws, worm-wheels and worms which are driven by power. This table carries a saddle which has a movement parallel to the main spindle. The saddle carries a cross table 24 by 36 inches in size, which also has a horizontal movement at right angles to the spindle. These tables can be lowered until the top table is 25 inches from the center of the spindle, and by removing the upper tables, which are 6¼ inches thick, this distance is increased to 31¼ inches. In addition, a circular table may be provided, as shown in the illustration, for handling work where it is necessary to bore holes at different angles without resetting. The circular table is graduated through a full circle and may be moved by hand to any required angle. This table rests on top of the rectangular table, to which it is secured by corner clamps.



Combination Boring, Drilling and Threading Machine built by Betts Machine Co.

For machining both ends of a casting at one time, an extra or right-hand facing head may be provided which can be arranged to clamp on a boring-bar or to fit a hole in the steadyrest yoke. The illustration shows a machine which is equipped with a threading attachment arranged to give suitable feeds to the boring spindle so that threads of different pitch can be cut in pump valve seats and similar work after it has been bored. Threading is done with a tool of the chaser type. For milling, a power feed mechanism can be provided for the top rectangular table and also for the circular table. The illustration shows a machine equipped with electric motor drive, but the same type of machine is also built for cone pulley drive.

READY ELECTRICALLY WELDED TOOLS

The Ready Tool Co., 550 Iranistan Ave., Bridgeport, Conn., is now manufacturing a line of arc- and butt-welded tools in which a cutter of either stellite or high-speed steel is electrically welded to a machine steel shank. This enables all of the cutter to be used up—a condition of exceptional importance at this time when the cost of these materials is so far above normal. In Fig. 1 the tools have stellite cutters, and in the case of the upper tool shown in this illustration particular attention is called to the fact that the stellite is welded onto the shank at such an angle that both front and side clearance is provided. This is an important matter, because stellite is made as a casting, and in sharpening the tool it is merely necessary to grind

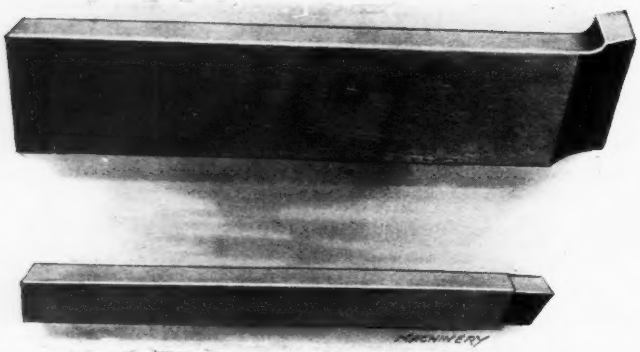


Fig. 1. Ready Tools with Stellite Cutters arc- and butt-welded to Machine Steel Shanks

the top face, thus leaving the surface metal intact on the sides, experience having shown this to be considerably harder than the interior metal. Also the cut is made with the grain of the stellite, which is an important feature, because the material is stronger with than across the grain. The shank is machined with a projection at the front that forms a base upon which the stellite cutter is supported in addition to being welded to the shank, thus insuring a full support right under the nose of the tool. The lower tool shown in Fig. 1 has the stellite butt-welded to the shank.

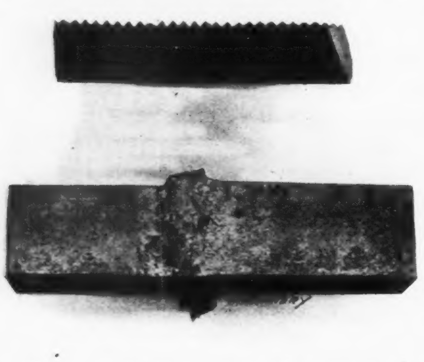


Fig. 2. Tool-holder Cutter with High-speed Steel butt-welded to Machine Steel

Fig. 2 illustrates the way in which high-speed steel is butt-welded to machine steel in order to form a tool-holder cutter that will allow all the high-speed steel or stellite to be utilized. Stellite could not be used in this butt-welded form, and if it is desired to use it, a section must be arc-welded to the front of the cutter by the new process. In all cases, the welding of either high-speed steel or stellite is so perfectly done that the joint shows a complete fusion; and the welding is done so rapidly that it is claimed the high-speed steel cutters are not heated sufficiently to affect the results obtained by the heat-treatment. In addition to the straight forms of tools shown, off-sets of all shapes, and also—what is very desirable—cutting-off blades with stellite tips are being made by the company for handling work on lathes, boring mills and screw machines.

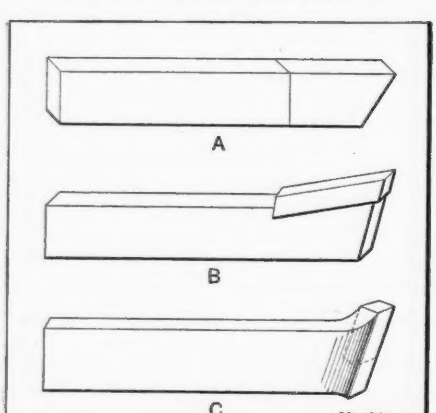


Fig. 3. A, Butt-welded Tool; B and C, Arc-welded Tools

"NASITRA" MARKING FLUID

The Artisan Chemical Supply Co., Box 395, Detroit, Mich., is now manufacturing a fluid compound known as "Nasitra" for use in marking metal products. "Nasitra" is especially adapted for marking products made of those grades of steel commonly used in the manufacture of tape measures, gages, scales, etc. It is used without requiring the metal to be first coated with paraffin, wax or soap, the only requirement being that the surface of the metal to be marked must be perfectly clean. Then the fluid is applied with a pen or sharpened piece of wood. Manufacturers who have a large number of carbon or high-speed steel products to mark should find this compound very useful.

Tool marked with "Nasitra"

CORRECTION OF WEIGHT, BAKER DRILLING MACHINE

A misleading statement appeared at the conclusion of the description of the Baker heavy-duty drilling and boring machine in the October number, as regards the weight. The weight of the three assembled machines with a common floor plate, as illustrated, is 66,000 pounds. The weight of 18,000 pounds given was the estimated weight of a single-spindle machine.

NEW MACHINERY AND TOOLS NOTES

Adjustable Male Gage: Nils E. Larson, Chicago, Ill. An adjustable male gage which has the body made of steel and adjustment of the measuring points provided by means of a wedge actuated by a knurled nut.

Sine Bar: Model Tool & Gage Co., 187 John St., Bridgeport, Conn. A tool known as the "Simplex" sine bar which can be used in conjunction with a table of natural sines and cosines for the accurate determination of angles. It measures 5 inches from center to center of the disks and forms a useful addition to the toolmaker's kit.

Combination Drawing Tool: Two Rivers Drawing Tools Co., Two Rivers, Wis. A combination drawing instrument designed to save time in laying out hexagonal and other forms in the use of the isometric system. The instrument can be quickly handled and covers a wider range than would be thought to be the case before the draftsman has had experience in its use.

File Handle: Strong-Hold Mfg. Co., 307 Arch St., Philadelphia, Pa. A wooden handle of ordinary form which is drilled to receive the file tang. Two saw slots crossing each other at right angles pass axially through the tang hole. The ferrule is in the shape of a helical spring; and when it is driven into the handle, it closes the slots and gives an elastic grip on the file tang.

Precision Square: Simplex Tool Co., Woonsocket, R. I. A square made of hardened steel and accurately ground to a fine edge on two sides and flat on opposite sides. The fine edges in contact with the work are claimed to enable the detection of an error less than 0.0001 inch in 3 inches. Holes are provided in the square to afford an efficient finger grip for every method of applying the square to the work.

Patternmakers' Bench Planer: J. D. Wallace, 527 Van Buren St., Chicago, Ill. A small bench machine adapted to meet the requirements of patternmakers and other woodworkers. It will take heavy cuts in hard wood as well as soft, and the finish produced is entirely free from knife marks. A guard provides for the protection of the operator; and the planer is driven by a motor that takes power from an ordinary lamp socket.

Offset Boring Head: Reliance Tool Co., 134 Eliot St., Boston, Mass. This boring head consists of two essential parts, which are two eccentric bushings, one within the other. The hole in the outer bushing is bored 0.050 inch off center, and the hole in the inner bushing which supports the cutter-bar is also off center. By adjusting these two bushings in relation to the center, the required amount of offset may be obtained.

Oilstone Grinder: Oliver Machinery Co., Coldbrook and Clancy Sts., Grand Rapids, Mich. An oilstone grinder developed for use in quickly sharpening all kinds of knives and tools. Two grades of oilstones are provided, one for rapid abrasion and the other for putting a keen edge on the tool. Kerosene oil is used on the wheels and is liberally applied, a special device being provided which prevents the oil from being thrown by centrifugal force.

Sensitive Drilling Machine: Cincinnati Pulley Machinery Co., Covington, Ky. A machine with a base 24 by 26 inches in size in which T-slots are cut to provide for holding heavy castings; and in addition, the machine has a round table 24

inches in diameter that can be swung out of the way when the lower base is used. The maximum distance from spindle to round table is 18 inches, and the maximum distance from spindle to lower base is 42½ inches.

Quenching Machine: U. S. Electro-Galvanizing Co., 1 Park Ave., Brooklyn, N. Y. A machine that enables hardening, pickling, cleaning and drying of shells to be performed continuously. In operation, the shells come from the furnace at a red heat and are dumped into a perforated receiving tank which is partially immersed in water so that the shells are quenched. They then pass on through successive tanks and compartments in which are performed the other operations.

Hand Screw Machine: Stenotype Co., Indianapolis, Ind. A turret hand screw machine fitted with a three-step cone pulley, which is covered by a guard that serves the additional purpose of forming a well and tying the front and rear spindle bearings together. The headstock is cast integral with the bed, and a cut-off slide is provided with gibbed bearings. This machine swings 13½ inches over the bed and 6 inches over the cut-off slide; the capacity is for handling bar stock up to 1 inch in diameter.

Air-operated Hammer: Buffalo Foundry & Machine Co., Buffalo, N. Y. A steam forging hammer arranged to be driven by compressed air. The compressor used in connection with this hammer can be equipped for plain belt drive direct from an individual motor that forms part of the compressor equipment. The receiver tank can be placed in either a vertical or horizontal position at any convenient location near the hammer and compressor, according to the requirements of individual cases.

Band Grinder: Victor Machine Co., Albany, N. Y. An abrasive band grinder for use in the performance of surface grinding operations. The abrasive band is jointless and is drawn over the table by the main driving pulley. A band tension pulley takes up slack, and quadrants are provided for adjusting the pulley centers to allow for unequal stretch in the band. The band may be rapidly put on the machine or removed without requiring the aid of tools. This machine is built for the Selson Engineering Co. of New York City.

Cutting-off Machine: Etna Machine Co., Toledo, Ohio. A machine adapted for cutting off solid or tubular stock up to 6 inches in diameter. It is equipped with a geared head which provides four changes of spindle speed, and the machine is adapted for operation at from 100 to 110 feet per minute cutting speed of the tool. Drive is provided by either a constant-speed motor or by a single pulley and belt from the lineshaft; and control is furnished by a friction clutch having a lever located within easy reach of the operator.

Geared Speed Reducer: Foote Bros. Gear & Machine Co., Chicago, Ill. An equipment known as the IXL speed transformer which is adapted for machine tool application, and was especially designed for use in places where dust and grit are likely to cause trouble. The reducer is of the double differential type in which the first part is non-planetary and the second section planetary. It is claimed that this mechanism eliminates the objectionable feature of having the first set of idlers fastened to a flat plate and rotating on the high-speed shaft.

Hand Screw Machine: Turner Machine Co., Danbury, Conn. A hand screw machine in which the spindle is mounted in phosphor-bronze lined bearings which are grooved and provided with sight-feed oil cups. The stock feed is operated by a conveniently placed lever; and the cut-off rest is fitted with a locating clamp furnished with an adjustable stop and screws, and equipped with a rack and pinion operating lever. The two toolposts have step wedges to provide adjustment for height. This machine was built for the Macnab Machinery Co. of New York City.

Air-operated Arbor Press: Haniffin Mfg. Co., Chicago, Ill. An air-operated machine intended to increase production and eliminate fatigue caused by performing heavy pressing operations by hand. The downward stroke is steady, while the upward stroke is made at fast speed. The arbor has a stop collar which enables the downward stroke to be set to a definite stop, so that duplicate operations can be performed semi-automatically. The press is made in two sizes; the No. 1 has a maximum capacity from base to arbor of 16 inches, and the No. 2 has a maximum capacity from base to arbor of 23 inches.

Lathe Milling and Grinding Attachment: Edward N. Moor, 765 Kingston Ave., Oakland, Cal. A universal milling and grinding attachment which is capable of handling all classes of work that can be done on centers or on the faceplate of a lathe. The device is attached by a bolt passing through its column to the carriage, or to the compound or plain cross-slide; and the interchanging of spindles for grinding or milling is accomplished by releasing and tightening two nuts on the sleeve. The attachment may be used to the right or left, in front or behind the column, and at any elevation or angle, so that it is fully universal.

Hacksaw Blade Grinding Machine: Wardwell Mfg Co., Cleveland, Ohio. In the July, 1914, number of MACHINERY a description was published of a model A-2 hacksaw blade sharpening machine of this company's manufacture. The present model H machine is of very similar design, being adapted for sharpening the blades of power hacksaw machines. This grinder is automatic in operation and saws can be fed through at the rate of sixty-five teeth per minute. This means that from fourteen to eighteen blades 18 inches in length can be re-sharpened in an hour; and the adjustment is so perfect that as little as 0.0005 inch can be removed from the teeth.

Cold Saw: Newton Machine Tool Works, Inc., Philadelphia, Pa. A small sized cold saw adapted for handling round stock up to 5½ inches in diameter. In many respects the design of this machine is similar to that of previous types of cold saws built by this company; the present machine is provided with geared feed in place of friction feed. This cold saw is of the spindle-driven type, the spindle revolving in capped bearings and being driven by spur gears which receive power from a worm and worm-wheel. The worm is fitted with a roller thrust bearing and the worm-wheel is made of solid bronze. The saw blade is 20 inches in diameter and may be of either the solid or inserted-tooth type.

Disk Grinder: Pioneer Dustless Disk Co., Syracuse, N. Y. A motor-driven disk grinder especially adapted for use in wood and metal pattern shops, although it could be used with satisfaction on many other classes of disk grinding. The most noteworthy feature of the machine is the provision of a self-contained vacuum dust removing system which collects dust as fast as it is formed and carries it away from the machine through an exhaust pipe into a sack or out of the window. The back of the disk is made in the shape of a fan, and a guard encloses the whole back of the disk and lower portions of the front part of the disk, thus forming a complete exhaust system so that there is practically no dust permitted to accumulate on the work.

Horizontal Rail Drilling Machine: Newton Machine Tool Works, Philadelphia, Pa. A five-spindle horizontal rail drilling machine which was designed to provide for drilling holes on close centers and to afford ample driving power. The machine is furnished with a two-spindle head and a three-spindle head; the position of the center spindle in the three-spindle head is fixed, and the two outside spindles are adjustable by means of an operating screw; both spindles in the two-spindle head can be located within one inch of the center line of the fixed spindle in the three-spindle head, thus making possible the drilling of holes within one-inch center distance from each other. The range of spindle adjustment on the three-spindle head is from 4 to 10½ inches between centers. On the two-spindle head the range of adjustment is from 4 to 19 inches between centers.

* * *

N. M. T. B. A. CONVENTION

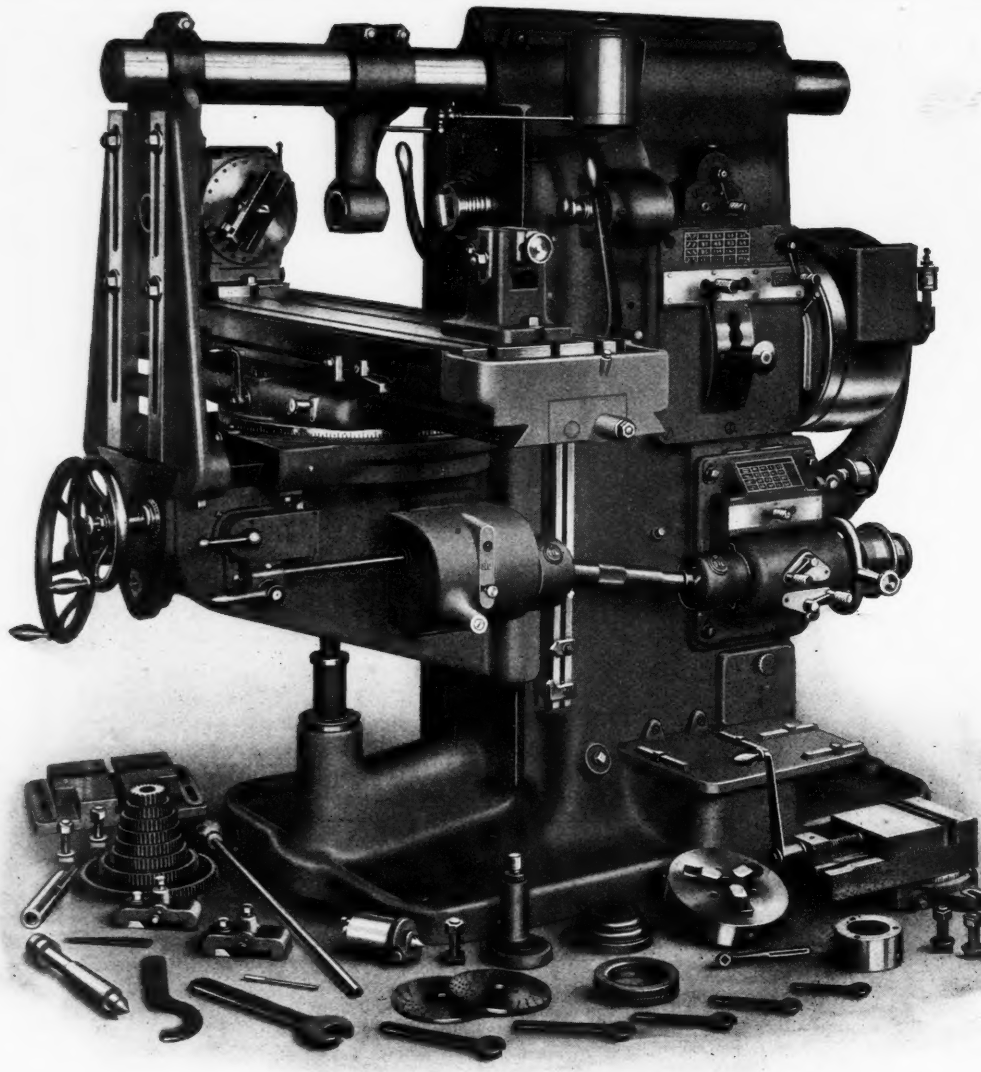
Continued from page 261.

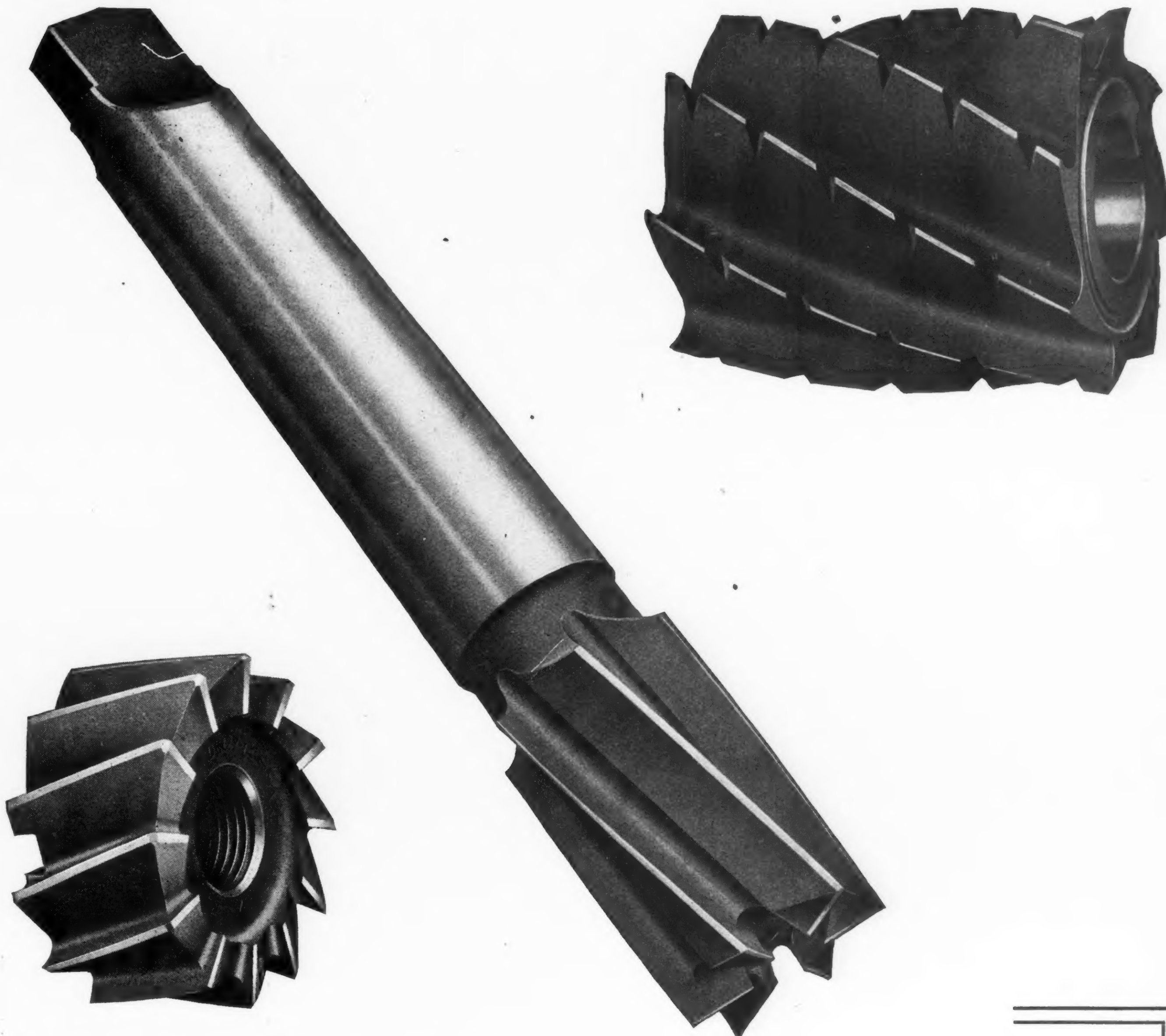
Frank F. Dresser of Worcester, Mass., counsel for the American Steel & Wire Co., delivered a scholarly and exhaustive address on health insurance, in which he reviewed the proposed health compensation or insurance law of twenty-two states and pointed out some of the difficulties and dangers attending the establishment of compulsory health insurance, quoting from the experience of Germany, Great Britain and other countries. Mr. Dresser advocated sickness prevention as being preferable to health insurance, both as regards the welfare of the worker and the welfare and prosperity of the employer and community as a whole.

On Tuesday afternoon and the following forenoon the time of the members was given over mainly to committee meetings on lathes, gear-cutting machines, boring machines, grinding machines, hand screw machines, planing machines, milling machines, shaping machines, vertical drilling machines, turret lathes and radial drilling machines. The committee meetings Wednesday forenoon were suspended to hear a talk by Alexander Luchars, publisher of MACHINERY, on machine tool conditions observed in Europe during his visit to Great Britain, France, Italy and Switzerland last summer.

Wednesday afternoon James A. Emery of the National Association of Manufacturers, Washington, D. C., addressed the convention on the subject "Industry and Politics." He pointed out the danger of rising labor costs and decreasing labor efficiency that will confront American manufacturers in the competitive struggle for world-trade which will inevitably follow the close of the war.

The officers of the association were re-elected as follows: J. B. Doan, president; D. M. Wright, first vice-president; A. H. Tuechter, second vice-president; C. S. Taylor, secretary; A. E. Newton, treasurer. The spring convention will be held at Cincinnati, Ohio, May 21 and 22.





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PERSONALS

Carl L. Svensen has opened an evening school of drafting under the name of the Ohio Technical Drawing School, in Columbus, Ohio.

G. F. Oliver, for the past year on the engineering staff of the Hopkins & Allen Arms Co. of Norwich, Conn., has been appointed night superintendent of the plant.

P. W. Gilbert, assistant sales manager of the Standard Welding Co., Cleveland, Ohio, for the past five years, has been made sales manager following the resignation of H. A. Flagg.

Benton G. L. Dodge, who for some years has had charge of the advertising and publicity work of the Standard Welding Co., Cleveland, Ohio, has been made manager of sales promotion.

B. D. Gray, manager of the Hess-Bright Mfg. Co., Philadelphia, Pa., has been elected president, succeeding F. E. Bright. Mr. Bright will continue to act as chairman of the board of directors.

H. W. Dow has been made sales manager of the Nordberg Mfg. Co., Milwaukee, Wis. Mr. Dow has been associated with the company in the engineering and sales departments for the past twelve years.

Walter C. Voss, formerly in charge of the Cleveland district of the Standard Welding Co., Cleveland, Ohio, has been put in charge jointly with Ted Palmer of the Detroit office, following the resignation of Charles E. Miller.

William R. King, formerly of the E. S. Jackman Co., agent in the Pittsburg territory for the Firth-Sterling Steel Co., has become associated with William K. Stamets, machine tool dealer, Jenkins Arcade Bldg., Pittsburg, Pa.

B. M. W. Hanson, vice-president and works manager of the Pratt & Whitney Co., Hartford, Conn., has been appointed member of the board appointed by Secretary Baker of the war department to investigate the machine gun situation.

James Cran, a well-known contributor to MACHINERY on forge work and kindred topics, has taken a position with the De Laval Separator Co., Poughkeepsie, N. Y., where he will have charge of the forging and heat-treating departments.

Donald Baker, assistant superintendent, Liberty Fuse & Arms Corporation, Long Island City, N. Y., and a contributor to MACHINERY, has resigned his position to become tool-room foreman of the Williams Mfg. Co., Ltd., Montreal, Canada.

B. A. Quayle, who for years has had charge of the Chicago office of the Standard Welding Co., Cleveland, Ohio, and who was one of the first salesmen employed by the company, has been made general representative, with headquarters at Cleveland.

Sven Wingquist of Gothenburg, Sweden, inventor of the S. K. F. ball bearing, visited the new American factory of the S. K. F. Ball Bearing Co. at Hartford, Conn., in September. Mr. Wingquist is president of the Swedish company and trustee of the American company.

P. H. Reardon has resigned his position as president of the General Machinery & Supply Co., San Francisco, Cal., having disposed of his interest to his associates. Joseph A. Buckley succeeds Mr. Reardon as president. A. L. Green is vice-president and H. F. Jurs, manager.

Thomas Crowther of T. Crowther & Co., 170 Oliver St., Boston, Mass., machinery merchants, has sold out his interest in the company, and has started another business in the same line, which will be known as the Thomas Crowther Co. The address of the new concern is 19 Pearl St., Room 24, Boston, Mass.

OBITUARIES

Frederick W. Hoefer, president of the Hoefer Mfg. Co., Freeport, Ill., died September 28, aged sixty-two years.

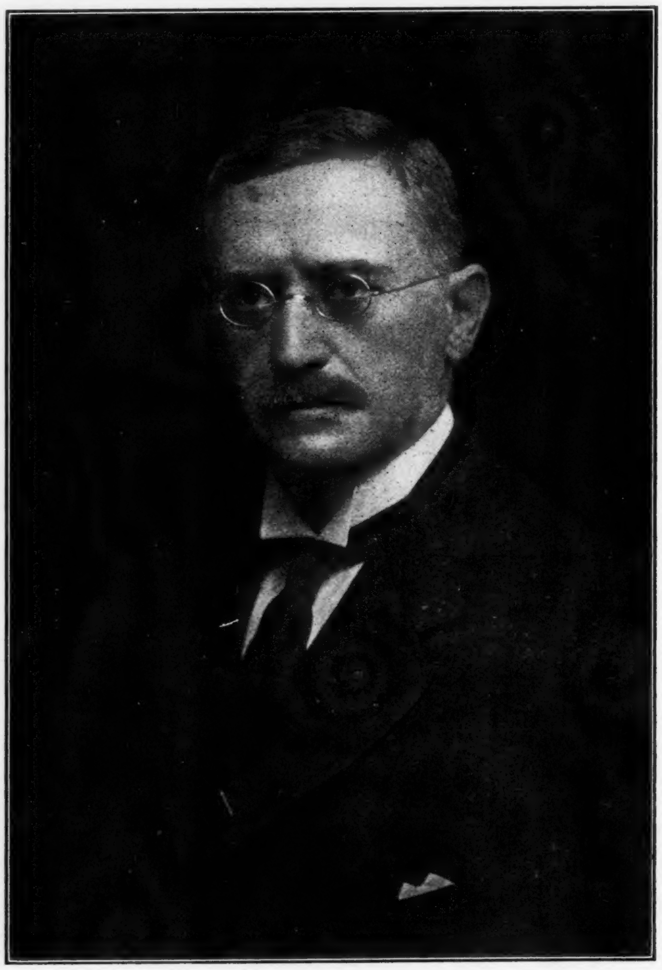
James H. Anthony, for many years employed by the Brown & Sharpe Mfg. Co., Providence, R. I., died at his home in Providence, October 7, aged seventy-six years.

E. W. Tucker, traveling engineer salesman for the Allis-Chalmers Mfg. Co., Milwaukee, Wis., and formerly with the E. P. Allis Reliance Works, died October 5, following a long illness, aged sixty-seven years. He was born in Milwaukee and enlisted during the Civil War, serving until its close, when he followed the profession of a civil engineer for a time. He later became associated with the E. P. Allis Reliance Works, and was a confidential co-laborer with the late Edwin Reynolds. Mr. Tucker was a large-hearted man, having many friends in the organization and in the engineering field; he traveled over the country—from Maine to California—and was well known. He leaves a widow and one daughter.

Samuel N. Trump, president of the Trump Bros. Machine Co., Milwaukee, Wis., died at his home in Wilmington, Del., October 5; the following day he would have been eighty-one years old. Although born in Baltimore, he began his manufacturing career in Port Chester, N. Y., where he joined his brother, C. Newbold Trump, who was engaged in the manufacture of machinery. In 1873, the two brothers and Christian Frederick moved from Port Chester to Wilmington, Del., where they started the establishment that six years later was organized as the Trump Bros. Machine Co., with C. Newbold Trump as president, Samuel N. Trump, vice-president, and Christian Frederick, superintendent. After the death of C. Newbold Trump, in 1912, Samuel Trump was elected president, George R. Hoffecker, vice-president and treasurer, Christian Frederick, general manager and secretary, and William Frederick, superintendent, which is the present organization. Mr. Trump, however, had not taken a very active part in the management for several years, having practically retired from business about ten years ago. Mr. Trump was a director of the Wilmington Trust Co., and for some time was president and general manager of the Arnoux Electric Co., the predecessor of the Wilmington Electric Co., and was largely responsible for its development. He was also at one time a member of the board of education, and it was largely through his influence that the manual training system was introduced into the schools of Wilmington. He is survived by a widow, four sons, and two daughters.

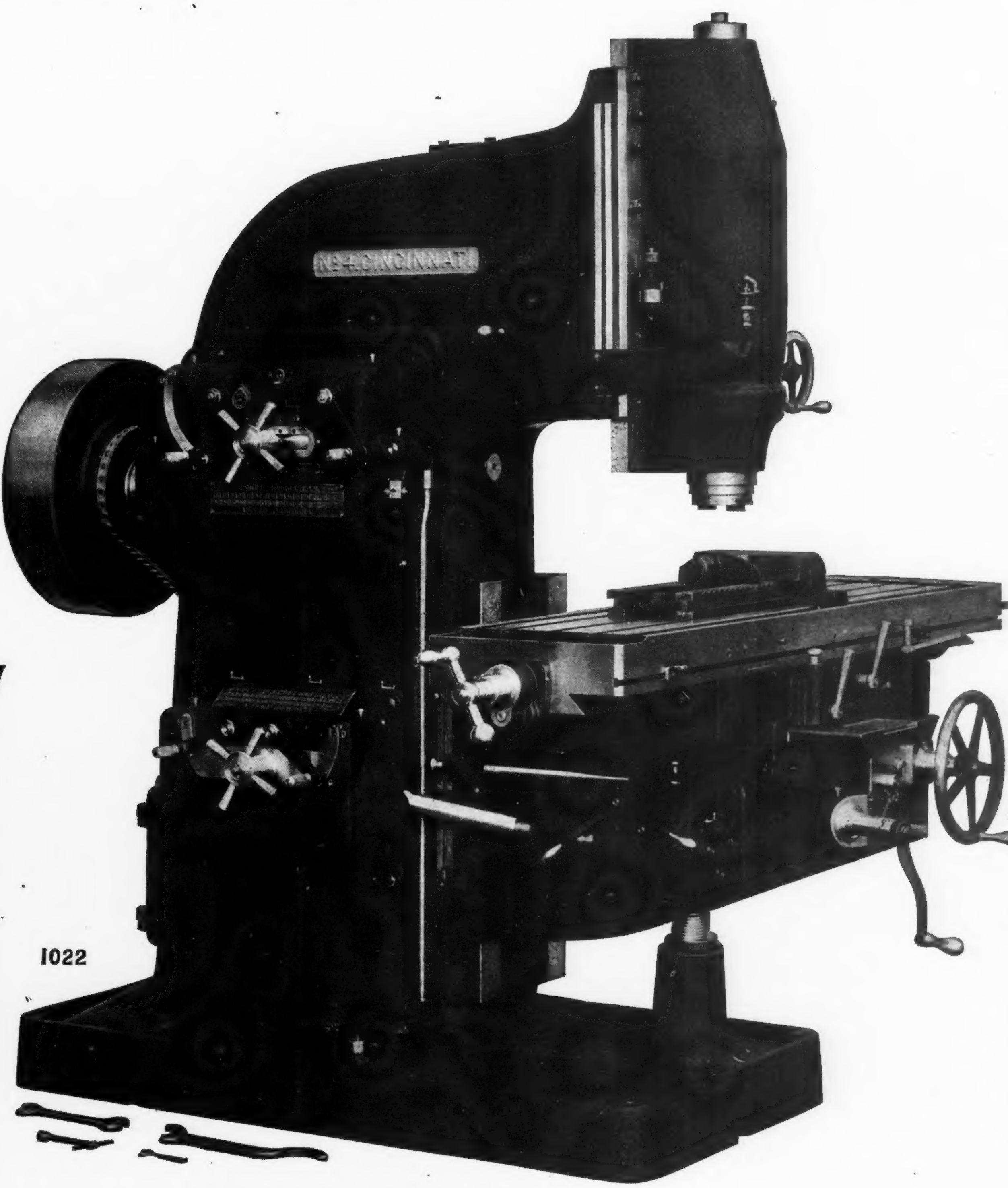
ROBERT C. McKINNEY

Col. Robert C. McKinney, chairman of the board of directors of the Niles-Bement-Pond Co., died at his home in Belle Haven, Conn., October 3, aged sixty-four years, after an illness of more than two years, the result of a nervous breakdown. He was born in Troy, N. Y., at a time when that community was especially distinguished by manufacturing interests associated with machinery, stoves and ranges, and other iron and steel products. His father, Robert McKinney, appears to have been identified there with certain lines of hardware manufacture, and in 1861 he became a member of a firm of hardware manufacturers in Cincinnati, Ohio, to which city he therefore moved. Later, two of his sons established a manufacturing company at Hamilton, Ohio, so that young McKinney early acquired a knowledge of the business of manufacturing. Robert C. McKinney was educated in the grammar and high schools of Cincinnati, graduating from the latter when eighteen years of age. Having a strong bent for mechanics, he entered the mechanical engineering department of Cornell University in the early seventies. After leaving the university, he was



Col. Robert C. McKinney

CINCINNATI VERTICALS



1022

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employed in the drafting-room and office of Cope & Maxwell, manufacturers of steam pumping machinery in Hamilton. The plant, business, and machinery of this firm he later purchased, when the International Steam Pump Co. was formed. At this time Hamilton had already gained considerable distinction as a manufacturing center and a producer of machine tools. In 1877 Mr. McKinney became associated with the Niles Tool Works, which was then one of the most important builders in the United States west of Philadelphia. Two years later he was made secretary of the company and a short time afterward treasurer and general manager. In this position he showed marked ability as an organizer and mechanical engineer, and a thorough knowledge of manufacturing. Later in life he was recognized throughout the nation as one of the foremost organizers of big business. So well did he fill the positions of treasurer and general manager, that though the country was just recovering from the effects of the panic of 1873, the business grew so rapidly that it became necessary to reorganize and increase the capital to $2,000,000. It was during this period that he gained the title of Colonel by service on the staff of Governor Bushnell of Ohio. The first step in the formation of the Niles-Bement-Pond Co. was taken, in 1898, by purchasing the Pond Machine Tool Works, of Plainfield, N. J. The purchase of the Bement-Niles Co. of Philadelphia, and the Philadelphia Engineering Works soon afterward, was followed by the organization of the combination in 1899. This company is now one of the largest in the world and produces machine tools for all purposes, electric traveling cranes, small tools, rifle-making machinery, etc. It has since acquired the Pratt & Whitney Co. of Hartford, Conn., the John Bertram Co. of Dundas, Ontario, and the Ridgway Machine Co. of Ridgway, Pa. Col. McKinney always took an active interest in the civic and religious life of his city, but refused to seek an election as Congressman from a desire to devote all his energies to the business he had so active a part in building up. He was a member of several clubs, the American Society of Mechanical Engineers, and the Machinery Club of New York, of which he was at one time president. He is survived by his wife and a daughter, Mrs. Sanford Ethrington, of New York.

COMING EVENTS

November 15-18.—Annual meeting of the Electric Power Club at Hot Springs, Va. Homestead Hotel, headquarters. C. H. Roth, secretary-treasurer,, 1440 W. Adams St., Chicago.

November 16-18.—Open conference of the Efficiency Society in New York City. Willis B. Richards, chairman, and M. L. Havey, secretary, 52 Broadway, New York City.

November 30.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St. E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

December 5-8.—Annual meeting of the American Society of Mechanical Engineers in New York City. Engineering Societies' Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

January 6-13.—National Automobile Show in Grand Central Palace, New York City.

SOCIETIES, SCHOOLS AND COLLEGES

Engineering Society of Buffalo, Buffalo, N. Y. Program of the meetings for the season, comprising papers on motion study, aeronautics, graphite, four-cylinder engines, highway bridge floors, nonferrous alloys, pure science applied to engineering, standardization, industrial education and apprenticeship. W. J. Gamble, 247 Rano St., Buffalo, N. Y., is the secretary.

Ohio Technical Drawing School, 1348½ N. High St., Columbus, Ohio, was opened October 3 by Carl L. Svensen. The school offers an evening course in drafting, and its purpose is to furnish an opportunity for draftsmen, machinists, patternmakers, molders and others engaged in mechanical lines to study drawing as a means to increase their value and obtain better pay. The addition of courses in mechanism, mechanics, strength of materials, and machine design is planned in the near future. Catalogues and blueprints are requested from manufacturers.

NEW BOOKS AND PAMPHLETS

A System of Accounts for Retail Merchants. 19 pages, 6 by 9 inches. Published by the Federal Trade Commission, Washington, D. C.

Health Conservation at Steel Mills. By J. A. Watkins. 36 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper No. 102.

Specific Gravity Studies of Illinois Coal. By Merle L. Nebel. 49 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin No. 89. Price, 30 cents.

International System of Electric and Magnetic Units. By J. H. Dellinger. 32 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 292.

Dry Preparation of Bituminous Coal at Illinois Mines. By E. A. Holbrook. 133 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price, 70 cents.

Automobilist's Pocket Companion and Expense Record. By Victor W. Page. 169 pages, 5 by 7½ inches. Published by Norman W. Henley Publishing Co., New York City. Price, $1.

This book contains blank forms for the keeping of expense accounts by motor car owners. About thirty-five pages are devoted to useful information for motorists on lubricating oil, care of storage batteries, tires, road troubles, etc.

The Model T Ford Car. By Victor W. Page. 300 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley Publishing Co., New York City. Price, $1.

This is the 1917 edition of a book for owners of Ford automobiles. It treats of the construction, operation and repair of Ford cars in a non-technical but thorough manner. Over 100 especially made drawings and photographs are used to illustrate the text.

How to Make Low-pressure Transformers. By F. E. Austin. 22 pages, 4½ by 7¼ inches. Illustrated. Published by Prof. F. E. Austin, Hanover, N. H. Price, 40 cents.

The increasing popularity of this book has made a third edition necessary. The additional matter in the new edition covers a simple form of core construction, instructions to amateurs for making a core for a small transformer without disks, and the utilization of discarded tin cans as transformer cores.

Electric Units and Standards. 68 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 60. Price, 15 cents.

The publication gives comprehensive and up-to-date information regarding the units and standards in terms of which electric and magnetic measurements are made. It includes the history of the units and the evolution of the definitions upon which the laws on electrical standards are based. The laws of this and other countries are given.

Examples in Alternating Currents. Vol. I. By Prof. F. E. Austin. 223 pages, 5 by 7½ inches. Illustrated. Published by Prof. F. E. Austin, Hanover, N. H. Price, $2.40.

This work, previously noted in MACHINERY, has passed into the second edition and new matter has been added. The success of the work made the publication of the second edition necessary. While not designed for a textbook, it is being used as such by students of electrical science. The title expresses the nature of the work clearly, it being devoted to a demonstration of the principles of alternating currents by the use of many well-chosen examples.

Electric Motors—Direct and Alternating. By David P. Moreton. 241 pages, 4¼ by 6½ inches. Illustrated. Published by Frederick J. Drake & Co., Chicago, Ill.

This book is of a convenient pocket size, and is intended for the practical man. It deals with the fundamental principles of electrical and magnetic circuits in the first three chapters. Chapter four treats of the common methods of measuring current, pressure, resistance, and power, and chapters five and nine are devoted to armature windings for both direct- and alternating-current motors. Chapters six, seven and eight are devoted to the different types of direct-current motors, and chapters ten, eleven and twelve treat of the different types of alternating-current motors.

Handbook of Machine Shop Electricity. By C. E. Clewell. 461 pages, 4 by 6¾ inches. Illustrated. Published by McGraw-Hill Book Co., Inc., New York City. Price, $3 net.

This book was written to supply the need for a convenient electrical reference book adapted to the machine shop. The contents are grouped under ten main headings, as follows: Abbreviations, Terminology and Units; Circuits; Costs; Communication and Distant Control; Current Supply, Generators and Transformers; Electrochemical, Soldering and Welding Applications; Heating and Magnetic Apparatus; Lamps and Shop Lighting; Measuring Instruments and Measurements; Motors and Applications. The book is printed on thin paper and bound in flexible cloth, to make it of convenient thickness and form to carry in the pocket for ready reference.

Hendricks' Commercial Register of the United States. 1890 pages, 7½ by 10 inches. Published by S. E. Hendricks Co., Inc., New York City. Price, $10.

The twenty-fifth annual edition of Hendricks' Commercial Register of the United States for buyers and sellers, which has just been issued, rounds out a quarter of a century of usefulness for this well-known publication. The work is especially devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. It contains about 350,000 names and addresses, with upward of 45,000 business classifications. Lists are included of producers, manufacturers, dealers and consumers, listing all products from the raw material to the finished article, together with the concerns handling these products from the producer to the consumer. An indication of the scope of the work is the fact that the index alone contains 149 pages, covering over 50,000 trade references. A new feature is the listing of trade-names, brands, titles of identification, etc., to which 202 pages are given. This section, printed on pink paper, furnishes ready reference for purchasing agents and prospective buyers to distinctive products manufactured by the firms listed.

Modern Shop Practice. Editor-in-chief, Howard M. Raymond. In six volumes. Vol. I, 345 pages; Vol. II, 375 pages; Vol. III, 347 pages; Vol. IV, 327 pages; Vol. V, 365 pages; Vol. VI, 377 pages. Page size, 5½ by 8 inches. Published by the American Technical Society, Chicago, Ill. Price of set, $15.80.

A general reference work on machine shop practice and management, productive manufacturing, metallurgy, welding, toolmaking, tool design, die making and metal stamping, foundry work, forging, patternmaking, and mechanical drawing. The first volume deals principally with measuring tools and gages, the use of hand tools in connection with assembling and fitting, and general methods of operating various classes of machine tools, such as lathes, planing machines, drilling machines, milling machines, grinding machines, and gear-cutters. Machine shop management, metallurgy, welding and die-stamping are the subjects treated in the second volume. The section on metallurgy is a general review of the standard processes of producing iron, steel, copper, and other common metals. The section on welding includes information on autogenous, electric and thermit welding, in addition to ordinary smith- or hand-welding operations, and different kinds of electrical and gas welding equipment are described. The eighty-six pages in this volume on die work deal principally with methods of making different types of punches and dies for blanking, drawing, forming and embossing sheet metal parts. The subject of toolmaking is treated in the third volume, in which is explained the general procedure in making small tools, such as arbors, taps, dies, milling cutters, reamers, etc., and the making of jigs and gages. This volume also deals with different types of dies and contains general information on tool design. The fourth book of this set is on foundry work and forging. The foundry section includes the making of cores and various classes of molds, and explains the construction and use of molding machines. It also treats of cupola operation, the production of malleable castings, brass castings, etc. In the forging section the general subjects are hand-forging operations, application of power hammers, drop-forging, and heat-treatment of steel. The fifth volume is on patternmaking and mechanical drawing. Many typical patterns and core boxes are shown and the method of construction is explained. The subject of mechanical drawing is divided into two parts: The first part deals with drawing instruments, construction of geometrical figures, methods of projection, and lettering. The second part, which is the beginning of the sixth volume, is on machine drawing, and treats of the practical side of drafting work, by explaining the methods of drawing various machine parts. The sixth volume also contains 112 pages on the features of motor car construction. Each volume, with the exception of the last, is supplemented by a list of review questions, pertaining to the more important subjects. The work as a whole is profusely illustrated and contains little that the average man would find complex or difficult to understand.

NEW CATALOGUES AND CIRCULARS

Porter-Cable Machine Co., Syracuse, N. Y. Circular illustrating and describing the taper attachment for the Porter-Cable manufacturing lathe.

Stenotype Co., Indianapolis, Ind. Circulars descriptive of the "Steno" 1 by 7 inch turret hand screw machine and the "Steno" duplex surface grinder.

Tate-Jones & Co., Inc., Pittsburg, Pa. Circular 151 on bolt heading forges and rod heating furnaces. Circular 152 on tool dressing furnaces and blacksmith forges.

Cowan Truck Co., 8 Water St., Holyoke Mass. Circular giving specifications for the Cowan transmobile, a new electric transveyor of 2000 and 4000 pounds' capacity.

High-Speed Hammer Co., Rochester, N. Y. Catalogue illustrating the line of riveting machines made by this company. These machines can be furnished with motor drive if desired.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-Z describing and illustrat-

ing single steam-driven air compressors with balanced steam valve and automatic flywheel governor.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 16 describes the forging of grab-irons on the National forging machine and points out the advantages of this machine for similar classes of work in railroad, industrial and automobile plants.

Vulcan Engineering Sales Co., Chicago, Ill. Catalogue showing the line of squeezers manufactured by the Mumford Molding Machine Co., of Chicago. Catalogue illustrating the Mumford Molding Machine Co.'s pattern drawing machines and castings produced in them.

Gurney Ball Bearing Co., Jamestown, N. Y., has begun the publication of a house organ, "Bearing on Bearings," which will appear at intervals. Volume I contains "Old Charlie," "One-Third Off," "Pushmobile," "Four of a Kind," "Sawdust" and "The Moral."

Macleod Co., 2232-2236 Bogen St., Cincinnati, Ohio. Bulletin O of the "Buckeye" file sharpening machine which may be operated with compressed air or steam. The bulletin gives some data on the savings effected by the use of the file sharpening machine for renewing worn files.

Himoff Machine Co., 50 Church St., New York City. Circular descriptive of the "Hercules" 21-inch heavy-duty manufacturing lathe, designed especially for heavy-duty plain, taper and form turning. This machine is adapted for any work done on the ordinary lathe with the exception of thread cutting.

New Departure Mfg. Co., Bristol, Conn. Sheets for loose-leaf catalogue, 75 FE to 78 FE, inclusive, treating of "Radax" type bearings in novel clutch; ball bearings in motor-driven elevator gearing; ball bearings in Riensch-Wurl sewage screen brush; head and spindle assembly of vertical surface grinder.

Tate-Jones & Co., Inc., Pittsburg, Pa. Circular 153, descriptive of plate and angle heating furnaces for heating plates for flanging or annealing, angles for bending or forming and rods for continuous bolt or rivet machines. Circular 154 on Tate-Jones overfired furnaces, for annealing and heat-treating.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin E-44 descriptive of the "Duntley" electric sensitive drilling stand, built in five sizes to take the standard "Duntley" side spindle drills of either the universal or direct-current types, ranging in drilling capacity from 3/16 to ½ inch in metal.

General Electric Co., Schenectady, N. Y. Bulletin 44419, illustrating and describing railway motor gears and pinions, made in several types for various classes of service, the chemical characteristics, physical characteristics and price being given for each type. The bulletin gives tables of gear formulas and shows diagrams of the comparative sizes of gear and pinion teeth.

Templeton, Kenly & Co., Ltd., 1020 S. Central Ave., Chicago, Ill. Catalogue 216, covering the complete line of "Simplex" jacks for steam and electric railroads, contractors' industries, automobiles, mining, public utilities and ordnance purposes. The catalogue illustrates these jacks in use for various purposes and gives the capacity of the different sizes, which is as high as forty tons for the railroad car jacks.

Waltham Grinding Wheel Co., Waltham, Mass. Catalogue of grinding wheels, containing information on ordering, selecting wheels for different kinds of work, and methods of mounting. Price lists are given for straight wheels, taper wheels, cup wheels, cylinder wheels, and wheels for various types of standard and special grinding machines, as well as wheels for tool grinding machines, knife grinding, hollow-ware grinding and saw gumming.

International Machine Tool Co., Indianapolis, Ind. Catalogue treating of the "Libby" lathe in manufacturing machine shops. The booklet shows the "Libby" lathe employed on various classes of work in manufacturing machine shops and reproduces sketches of pieces machined on these lathes, giving the time taken for each piece. The company has also issued similar booklets showing the "Libby" heavy-duty turret lathe in machine tool shops and "Libby" lathes in automobile shops, with examples of work.

Diamond Power Specialty Co., Detroit, Mich., has increased the size of its house organ, "Power Notes." The object of this four-page monthly is to bring to the attention of the consulting engineer, steam engineer, mechanical engineer and architect, information on certain phases of power plant work. Records of tests and photographs of installations are included. The company will mail the publication regularly to all engineers interested in power plant development and will send a loose-leaf folder in which the monthly copies may be filed for reference.

Spray Engineering Co., 93 Federal St., Boston, Mass. Bulletin descriptive of the "Spraco" paint gun, a hand tool for use in applying all kinds of liquid coatings. The complete equipment consists of the paint gun proper, connected by a flexible hose to a portable unit combining the material container, air drier and strainer, pressure control attachment and pressure gage. It is adapted for use in shop or field, and may be adjusted for spraying the highest grade of varnishes and lacquers, as well as heavy asphaltum and structural paints, producing finely finished surfaces without streaks or brush marks. It is also adapted to applying heavy, durable coatings to rough structures.

Pratt & Whitney Co., Hartford, Conn. Catalogue 9 of Pratt & Whitney small tools, including taps, dies, milling cutters, reamers, punches, drills, taper pins, lathe mandrels, ratchets, threading tools, counterbores, knurling tools, cutting-off tools, hollow-mills, circular forming tools, etc. The catalogue also contains a section of tables giving data on standard screw threads; pipe threads; standard machine screws; thread dimensions and tap drill sizes; constants for finding pitch diameter and root diameter of screw threads; decimal and millimeter equivalents; drill size decimal equivalents; and tables of speeds; weights per foot and weights per inch of bars of iron and steel; wire gage standards; table of tapers, etc.

Hyatt Roller Bearing Co., Newark, N. J. Bulletin 122, devoted to Hyatt flexible roller bearings for lineshafting, listing the advantages to be obtained by the use of these bearings and giving price lists and dimensions for bearings and hangers. Bulletin 202, describing Hyatt flexible roller bearings with planished steel outer races, suitable for light loads and medium speeds. Bulletin 401, on high-duty bearings for high-speed and heavy-load applications. Bulletin 1523 entitled "Engineering Helps on the Selection and Mounting of Hyatt Roller Bearings." This pamphlet contains instructions for mounting, which insure that a proper installation will be made in all cases. It is illustrated with halftone and sectional line engravings.

Greenfield Tap & Die Corporation, Greenfield, Mass. New catalogue 37, covering the entire line of gages, taps, dies, screw plates, reamers, threading machines, tap and die holders, friction tap chucks, Wells self-opening dies, pipe threading tools, etc., made by this company. This includes the products of the Wells Bros. Co., Wiley & Russell Mfg. Co. and A. J. Smart Mfg. Co., formerly catalogued separately. The catalogue also contains tables of tap drill sizes, screw threads, decimals of millimeters and equivalent decimals of inches, wire gage standards, three-wire thread measurements, allowances for fits, and other valuable data. A glossary gives the meaning of the various terms used in connection with the cutting and measuring of screw threads.

TRADE NOTES

Bath Grinder Co., Fitchburg, Mass., has changed its name to the Universal Grinding Machine Co.

Latrobe Electric Steel Co., Latrobe, Pa., has opened an office for the sale of its tool steel products in Cincinnati, Ohio. Edwin M. Ong is manager.

Precision Gage & Tool Co., Bridgeport, Conn., has moved to 166 Elm St., where larger quarters and new machinery have been provided to take care of the growing business.

Edgemont Machine Co., 2700 National Ave., Dayton, Ohio, maker of friction clutches, has completed a large addition to the plant that will about double the manufacturing facilities.

Woburn Gear Works, Woburn, Mass., manufacturers of gears, sprockets, chains, etc., are moving into their new, concrete shop, which will afford larger and better facilities for securing business.

Clarage Fan Co., Kalamazoo, Mich, has established a branch office in Chicago, at 123 W. Madison St. L. O. Monroe, who has had several years' experience in the fan business, is a representative in charge.

Colburn Machine Tool Co., Franklin, Pa., has purchased four and a half acres of land in Cleveland, Ohio, and will establish a branch plant there. The plot is on Ivanhoe Road, near the Reliance Electric & Mfg. Co.'s plant.

M. Adler, 32 Union Square, E., New York City, has established a temporary office for handling export of motor cars and motorcycles. Mr. Adler will also represent a few firms making tools and machinery used in motor car repair shops.

F. Raniville Co., Grand Rapids, Mich., manufacturer of leather belting, has opened a branch office in New York City at 6 Church St. George S. Baker, formerly secretary-treasurer of Olmsted-Flint Co., is the head of the New York selling organization.

Adamant Iron & Steel Co., Kent, Ohio, has brought out a brand of high-speed steel known as "Adamant," for which superior characteristics are claimed. The steel is said to be much harder than other brands of high-speed steel, and it can be tempered in oil or water without water-checking.

Doehler Die-Casting Co., Court and 9th Sts., Brooklyn, N. Y., has moved its brass-back bearing department from Brooklyn to its Toledo plant. An entire new factory building, housing foundry and machine shop, fully equipped with all labor-saving devices will be devoted to the exclusive manufacture of the Doehler babbitt-lined brass-back bearings.

Cisco Machine Tool Co., Cincinnati, Ohio, has completed a large addition to its plant which doubles the productive capacity. The company will soon place upon the market a 24-inch engine lathe. Considerable new equipment has been added and it is expected that the additional facilities will enable the company to make early deliveries in the near future.

Russian Metal Trading Co. (Iznosskoff, Suckau & Co.), Singer Bldg., 149 Broadway, New York City, will hereafter be known as Iznosskoff & Co. There has been no change in the organization and its policies will be the same as heretofore. S. A. Strolman, G. I. Demcker and V. A. Sindaeff of the machine tool and tool department continue in their respective relations. A. L. Buiwitt is in charge of the New York office.

F. O. Stallman Supply Co. has leased the premises at 129 First St., San Francisco, Cal., and will carry a complete line of high-grade machine tools, supplies and materials for machine shops, garages, factories, railroads, mines, mills, etc. F. O. Stallman, the senior member of the firm, was formerly vice-president and manager of the Pacific Tool & Supply Co., a firm which he and his brother, the late Charles Stallman, established twenty-five years ago.

Union Chain & Mfg. Co., Seville, Ohio, has increased its capital stock from $20,000 to $40,000, in order to take care of its rapidly growing business. Additional machinery will be purchased, including turret lathes, multiple-spindle drilling machine, automatic gear-cutter, keyseating machine, rolling mill, automatic screw machines, etc. The company has opened a New York office at 47 W. 34th St., in charge of J. R. Shays, Jr.

T. A. Willson & Co., Inc., 3rd and Washington Sts., Reading, Pa., has been awarded a large government contract for "Albex" eye protectors for use in the regular army. The "Albex" eye protector has been adopted and standardized by the War Department, and will soon be a part of the regular equipment of 50,000 troops. In addition to this order the company is making approximately 25,000 goggles for shipment to El Paso and other southern points for the National Guard.

Union Caliper Co., Orange, Mass., has changed its name to Union Tool Co. This change was considered advisable owing to the fact that since the company was started in 1908 for the purpose of manufacturing calipers, the line has been considerably enlarged. At present the company is manufacturing one of the largest lines of mechanical tools, including steel rules, combination squares, tool-holders, etc., and hence it was thought that the old name was misleading. No change has been made in the officers or personnel of the business staff.

G. L. Simonds & Co., 230 S. La Salle St., Chicago, Ill., announce that the company will be known in the future as the Vulcan Fuel Economy Co. The personnel and policies of the organization will remain the same as heretofore, the only change in addition to that of the name being an increase in capital, which was necessary in order to handle the growing business. The company will continue to sell Vulcan soot cleaners as well as Hays gas analysis instruments, and it has added to its line a new air-tight coating for covering boiler settings known as "Vulcan Lastite."

Haynes Stellite Co., Kokomo, Ind., has established branch offices as follows: 120 Broadway, Room 1846, New York City, Roe L. Johnson, manager; 900 Lytton Bldg., Chicago, Ill., A. F. Young, manager; 910 First National Bank Bldg., Cincinnati, Ohio, G. O. Litt, manager; 911 Citizens Bldg., Cleveland, Ohio, J. T. Plummer, manager; 318 Telegraph Bldg., Detroit, Mich., J. J. Cruice, manager. These branches will carry a complete stock of standard size solid stellite tools and arc welded stellite tools. The company was organized in the present form in November, 1915, and will close its first fiscal year with a sale of over $1,000,000 worth of stellite tools.

New Departure Mfg. Co., Bristol, Conn., gave an old-fashioned barbecue dinner to its 2700 employes on September 30. To feed this large number, eighty spring lambs were stretched on skewers and cooked over a trench 328 feet long filled with burning charcoal. Nine thousand ears of corn were prepared, and it was found necessary to supplement these with two thousand cans of corn. Thirty bushels of potatoes were boiled, and the bakers throughout the section were kept busy the night before making old-fashioned New England pumpkin pies. A miniature ice house was erected on the grounds to keep the beverages cold. Following the dinner a program of athletic sports was provided.

Inter-Continental Machinery Corporation, 165 Broadway, New York City, has been incorporated in the state of Delaware with a capital of $500,000. The company will deal in machinery in general, but will specialize in machine tools both in the United States and foreign countries. The president is Charles N. Thorn, who has been connected with the machine tool industry for twenty-five years, being associated with Manning, Maxwell & Moore, Inc., for fourteen years, and recently with the Allied Machinery Corporation of America as vice-president. The other officers are Joseph S. Clark, R. E. Robinson and Chester B. Overbaugh, vice-presidents; and Arthur M. Watkins, secretary and sales manager for the United States. The directors are, in addition to the president and vice-presidents, Frank J. Humphrey and George W. Kendrick.

Gisholt Machine Co., Madison, Wis., exhibited its "Periodograph" for recording workmen's time, at the Cleveland Foundry and Machine exhibit, September 11-16. The exhibit consisted of two controlling clocks operating several "Periodograph" registers. These registers were placed on stands or tables representing foremen's desks with a routing or production rack on each. The arrangement of the equipment gave a clear idea of how the registers might be placed in the different departments of the foundry or machine shop and all controlled by the clock in the superintendent's office. The help which the "Periodograph" gives the foreman was shown by the production rack at each register. These racks enable him to lay out a job ahead for each man at his convenience, and show him at a glance the jobs in process and the amount of interrupted work in his department.

Cowan Truck Co., 8 Water St., Holyoke, Mass., has moved into its new three-story building on North Canal St. The new building has a front of 100 feet and a depth of 200 feet, and a floor space of about 60,000 square feet. The building is of brick and concrete and is provided with foundations that will permit of the erection of two additional floors when required. The growth of the business has been phenomenal. In 1910, H. W. Cowan, then superintendent of the White & Wyckoff Mfg. Co., conceived the idea of the first Cowan truck, for moving paper in the White & Wyckoff plant, and its use has rapidly spread to all lines of manufacturing that handle parts. Over 2000 Cowan transveyors are in use in France and England alone. The officers of the company are H. W. Cowan, president; J. L. Wyckoff, vice-president; E. N. White, treasurer; and R. F. Lyon, general manager. The company is about to place on the market an electric transveyor equipped with a motor for transporting it and for elevating and lowering the load.